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Amendment to the Best Demonstrated Available Technology (BDAT) Background Document for Wastes from the Petroleum Refining Industry K048, K049, K050, K051, K052

Versar, Inc., Springfield, VA

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This background document provides the Agency's technical support and rationale for the development of treatment standards for the constituents to be regulated for the above-mentioned wastes.

This amendment prsents the K048-K052 solvent extraction and incineration data used to development the treatment standards for nonwastewaters; presents the K048 incinerator scrubber water data used to develop the treatment standards for cyanide in wastewaters; and provides EPA's rationale and technical support for various treatment standards.

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FINAL

AMENDMENT TO THE

FINAL BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT

FOR WASTES FROM THE PETROLEUM REFINING INDUSTRY

K048, K049, K050, K051, K052

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1.0 INTRODUCTION

1.1 Regulatory Background

On August 8, 1988, the United States Environmental Protection Agency (EPA or Agency) established best demonstrated available technology (BDAT) treatment standards for the listed wastes identified in Title 40, Code of Federal Regulations, Section 261.32 (40 CFR 261.32) as K048, K049, K050, K051, and K052, wastes from the petroleum refining industry.[1] The wastes are listed as follows:

K048 - Dissolved air flotation (DAF) float from the petroleum refining industry;

K049 - Slop oil emulsion solids from the petroleum refining industry;

K050 - Heat exchanger bundle cleaning sludge from the petroleum refining industry;

K051 - API separator sludge from the petroleum refining industry; and

K052 - Tank bottoms (leaded) from the petroleum refining industry.

Compliance with the BDAT treatment standards for these wastes is a prerequisite under 40 CFR Part 268 for placement of K048-K052 in land disposal units.

RCRA Section 3004(m)(1) states specifically that treatment standards are to be revised as appropriate. Therefore, EPA is not precluded from revising a treatment standard provided that rulemaking procedures are followed. EPA believes that revision of the promulgated K048-K052 treatment standards is appropriate at this time since additional treatment performance data became available to the Agency. The Agency's legal authority and promulgated methodology for establishing treatment standards and the petition process necessary for requesting a variance from the treatment standards are

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[1]These standards were promulgated in accordance with the amendments to the Resource Conservation and Recovery Act (RCRA) of 1976, enacted by the Hazardous and Solid Waste Amendments (HSWA) of November 8, 1984.

summarized in EPA's Methodology for Developing BDAT Treatment Standards (Reference 41).

The BDAT treatment standards for K048-K052 nonwastewaters that were promulgated on August 8, 1988 (in the final First Third rule) were developed based on data that were collected by EPA on incineration of these wastes, data that were submitted to the Agency on solvent extraction of the wastes, and data collected by EPA on stabilization of nonwastewater residuals. However, some of the solvent extraction data submitted to the Agency were not received in time to allow them to be fully evaluated before the promulgation date. As a result, treatment standards for xylenes and naphthalene in K048-K052 nonwastewaters had to be reserved because the Agency did not have data showing substantial treatment of these constituents from the solvent extraction technology used to develop BDAT treatment standards for the other regulated organic constituents. Since promulgation of K048-K052 treatment standards, the Agency has reviewed these data as well as additional new data submitted to the Agency following promulgation. The Agency has also recently conducted a test to collect additional data on solvent extraction treatment of K048 and K051.

Based on all data available at this time, the Agency is revising treatment standards for 14 regulated organic constituents in nonwastewater forms of K048-K052. The Agency is also establishing treatment standards for xylene and naphthalene (previously reserved) in nonwastewater forms of K048-K052. The Agency is deleting the treatment standards for two metal constituents, arsenic and selenium, in nonwastewater forms of K048-K052 and is revising the treatment standard for nickel. Finally, the Agency is adding cyanide as a regulated constituent in wastewater forms of K048-K052 and has developed a numerical BDAT treatment standard for cyanide. The BDAT treatment standards for organic and metal constituents in K048-K052 nonwastewaters and cyanide in K048-K052 wastewaters are presented in Tables 1-1 and 1-2, respectively. The treatment standards promulgated on August 8, 1988 for cyanide in nonwastewater forms of K048-K052 and for organic and metal constituents in wastewater forms of K048-K052 are not being revised at this time.

The Agency has decided to reschedule these wastes to the Third Third of the schedule and thus create a new prohibition effective date for them. The legal authority to take this action comes from "EPA('s)...continuing authority to reschedule wastes from one third of the schedule to another." Chemical Waste Management v. EPA, 869 F. 2d 1526 n.2 (D.C. Cir. 1989) (noting rescheduling of the prohibition for multi-source leachate that had already taken effect). The Agency is not undertaking this rescheduling casually. The determining factor in EPA's view, however, is that even though the wastes were prohibited in the First Third rule (and granted a two-year national capacity variance), petroleum industry members were in legitimate doubt as to what the ultimate treatment standards would be and, to some extent, what the technological basis for the standards would be.

The original standards promulgated by EPA were based on treatment of some of the less contaminated petroleum refining wastes. Subsequent efforts to reexamine and possibly amend the promulgated standards were delayed in part because of conflicting claims from the treatment industry regarding the equivalency of performance of three-pass and five-pass solvent extraction technology. The industry itself participated in research efforts regarding treatment tests on some of the more contaminated petroleum refining wastes and generated some useful data which were used to revise the promulgated standards.

As a result of this involved process, it could have been reasonably unclear to a petroleum refining facility whether treatment standards could be achieved using solvent extraction technology. Such a facility could have legitimately delayed its investment decision about what treatment technology to use to comply with the land disposal prohibitions. Given this situation, the Agency believes it is acting both reasonably and legally in exercising its authority to reschedule the wastes to the Third Third.

The Agency has determined that currently there is inadequate treatment capacity for generated K048-K052 wastes. The Agency expects the additional required treatment capacity to become available in the next six

months. Thus, the Agency is granting a six-month national capacity variance for K048-K052 from the effective date of the final Third Third rule. The revised treatment standards for organic and metal constituents in K048-K052 nonwastewaters and cyanide in K048-K052 wastewaters and the previously promulgated treatment standards for organic and metal constituents in K048-K052 wastewaters and cyanide in K048-K052 nonwastewaters will become effective on November 8, 1990.

1.2 Summary of This Amendment Document

This amendment to the Final Best Demonstrated Available Technology (BDAT) Background Document for K048, K049, K050, K051, K052 (Reference 40) (1) presents the K048-K052 solvent extraction and incineration data used to develop the treatment standards for nonwastewaters; (2) presents the K048 incinerator scrubber water data used to develop the treatment standards for cyanide in wastewaters; and (3) provides EPA's rationale and technical support for:

- Developing revised treatment standards for regulated organic and metal constituents in nonwastewater forms of K048-K052;
- Adding treatment standards for xylenes and naphthalene in nonwastewater forms of K048-K052;
- Deleting treatment standards for arsenic and selenium in nonwastewater forms of K048-K052; and
- Selecting cyanide as a regulated constituent and developing a treatment standard for cyanide in wastewater forms of K048-K052.

Sections 2.0 through 6.0 of this document amend sections in the Final BDAT Background Document for K048-K052 by presenting additional waste characterization data, treatment performance data, accuracy-corrected data, a rationale for the selection of cyanide as a regulated constituent in K048-K052 wastewaters and deletion of arsenic and selenium as regulated constituents in K048-K052 nonwastewaters, and calculation of new and revised treatment standards, respectively. Section 7.0 contains acknowledgements, and Section 8.0 presents an amended list of references. Appendix A provides an amended list of petroleum refinery plant codes and Appendix B contains quality

assurance/quality control data. Appendix C presents data from statistical tests comparing recently obtained data for stabilization of metal constituents in nonwastewater forms of K048-K052 to that used to develop the treatment standards promulgated on August 8, 1988 in the First Third Final rule. Appendix D presents detection limits for all constituents analyzed in the untreated and treated wastes from the Agency-sponsored solvent extraction test and for cyanide in the untreated waste and incinerator scrubber water from the Agency-sponsored incineration test.

The changes to the BDAT treatment standards for organic and metal constituents in K048-K052 nonwastewaters and for cyanide in K048-K052 wastewaters that are being promulgated in the Third Third rule are shown in Tables 1-1 and 1-2 and are summarized below.

1.2.1 Nonwastewaters- Organics

EPA received additional data from industry on solvent extraction treatment of K048-K052 after the close of the comment period for the proposed First Third regulation. These data were received too late for EPA to perform a complete evaluation and to incorporate the data in the development of the promulgated BDAT treatment standards. Since promulgation of the land disposal restrictions for First Third wastes in August 1988, the Agency has reviewed these data as well as additional new data submitted by industry after promulgation of the First Third rule and during the comment period for the proposed Third Third rule. The Agency has also recently completed a five-pass solvent extraction treatment test on a mixture of K048 and K051.

For the organic constituents being regulated in K048-K052 nonwastewaters, the Agency considered treatment performance data submitted by industry for the following technologies: three-pass solvent extraction, multicycle solvent extraction, amine solvent extraction, and high temperature thermal distillation. The majority of the data could not be considered in developing revised treatment standards for the following reasons: 1) data were not provided for a majority of the organic constituents being regulated, 2) untreated waste data were not provided and, therefore, no determination of

substantial treatment could be made, 3) a majority of the organic constituents being regulated were not detected in the untreated waste, 4) detection limits for the treated waste were several orders of magnitude higher than those achieved in other data sets, indicating nonoptimized laboratory procedures, 5) treatment was not demonstrated for a majority of the regulated organic constituents, and/or 6) adequate QA/QC data were not provided.

Two of the industry-submitted data sets for three-pass solvent extraction met the Agency's data quality screening criteria. The data set from the five-pass solvent extraction treatment test conducted by the Agency also met the screening criteria. These data sets were considered together with the incineration data used to develop the promulgated First Third treatment standards. Promulgated treatment standards for organic constituents in K048-K052 nonwastewaters were calculated with the combined pool of data. The Agency chose to use this combined pool of data from several sources in order to attempt to account for the complete range of variability that exists for K048-K052 wastes.

The Agency has not reevaluated the selection of solvent extraction and incineration as BDAT for organic constituents in K048-K052 nonwastewaters, but has instead incorporated additional solvent extraction treatment performance data into the revision of these treatment standards. Although the industry-submitted data from high temperature thermal distillation were insufficient to use for revising the BDAT treatment standards, the limited data available from this technology show that it can also meet all of the revised BDAT treatment standards. Therefore, high temperature thermal distillation should be considered an equivalent BDAT technology to incineration and solvent extraction. As is the case for all wastes for which concentration-based standards have been established, any treatment technology capable of achieving the treatment standards (including high temperature thermal distillation) may be used to treat these wastes.

The Agency also is promulgating nonwastewater treatment standards for two organic constituents for which it reserved treatment standards in the First Third rule, naphthalene and xylenes. The results from the recently

completed Agency-sponsored solvent extraction test and treatment tests conducted by industry provide treatment performance data for solvent extraction of naphthalene and xylenes as well as the other organic constituents being regulated in K048-K052 nonwastewaters. There are important environmental reasons to develop treatment standards for xylenes and naphthalene in these wastes. These solvents have been found to be present at high concentrations in these wastes (0.1 percent or higher), and at these levels, can readily mobilize land disposed hazardous constituents and degrade landfill liners resulting in increased leaching of hazardous constituents from land disposal units. The Agency is also concerned about the potential contribution of these constituents to VOC emissions from land disposal facilities. Thus, treatment of these constituents will clearly serve to reduce the migration, leaching, and volatilization of the hazardous constituents present in land disposed K048-K052 (and any wastes with which they are co-disposed) (see RCRA Section 3004(m)(1)).

1.2.2 Nonwastewaters - Metals

For the metal constituents being regulated in K048-K052 nonwastewaters, the Agency considered stabilization treatment performance data submitted by industry for the stabilization of solvent extraction raffinate, incineration ash, and incinerator combustion gas scrubber water solids using a variety of binders. The majority of the data could not be considered in developing revised treatment standards for the following reasons: 1) data were not provided for a majority of regulated constituents, 2) data on untreated wastes were not provided and, therefore, no determination of substantial treatment could be made, 3) detection limits were not provided for constituents that were not detected in the samples, and/or 4) treatment was not demonstrated for a majority of the metal constituents being regulated. Two of the data sets for stabilization of solvent extraction residuals and two for stabilization of incinerator ash met the Agency's data quality screening criteria, as discussed in Section 3.0 of this document. Statistical comparison of these data sets, along with the Agency-generated stabilization data used to develop the First Third treatment standards, showed that the data

representing the stabilization of solvent extraction raffinate demonstrated the best overall treatment for metals.

The Agency reviewed the treatment standards promulgated in the First Third final rule for the four regulated metal constituents in K048-K052 nonwastewaters and is deleting the treatment standards for arsenic and selenium. The data generated by the Agency that was used to develop the First Third treatment standards for arsenic and selenium showed only marginal evidence of stabilization treatment. None of the data submitted by industry showed substantial treatment for arsenic or selenium. As discussed in the proposed Third Third rule (54 FR 48431, November 22, 1989), the Agency believes that oxidation of these metals may be required prior to stabilization to achieve treatment of arsenic and selenium. The data submitted by industry showed significantly higher concentrations of nickel in the untreated wastes tested than the data for waste tested by the Agency. To ensure that the Agency is accounting for the maximum variability of nickel concentrations in K048-K052, the Agency is revising the treatment standard for nickel using the data submitted by industry for stabilization of solvent extraction residuals. The treatment standard for chromium has not been revised. All of the stabilization data submitted by industry indicate that the previously promulgated treatment standard for chromium is achievable for the complete range of K048-K052 wastes tested using stabilization treatment.

1.2.3 Wastewaters - Cyanide

For wastewater forms of K048-K052, the Agency is adding cyanide as a regulated constituent and has developed BDAT treatment standards for cyanide based on incineration of these wastes. At the time of proposal for the First Third wastes, the Agency did not have data on treatment of cyanide in wastewater forms of K048-K052 and did not have data on treatment of cyanide in other wastes that could be transferred to K048-K052 wastewaters. Data for cyanide in combustion gas scrubber water from incineration of K048 became available to the Agency too late in the regulatory schedule for the promulgated First Third rule. These data have now been used to develop the treatment standards for cyanide in K048-K052 wastewaters. The Agency expects

treatment of cyanide to occur using incineration technologies. Solvent extraction, although considered a BDAT technology for all other organic constituents regulated in K048-K052 nonwastewaters, has not been shown to treat cyanide.

Table 1-1

BDAT TREATMENT STANDARDS FOR
ORGANIC AND METAL CONSTITUENTS IN K048-K052
NONWASTEWATERS

(Constituents for which treatment standards are being revised)

Maximum for any Single Grab Sample

	BDAT List Constituent	Total Concentration (mg/kg) K048	K049	K050	K051	K052
4.	Benzene	14	14	NA	14	14
43.	Toluene	14	14	NA	14	14
226.	Ethylbenzene	14	14	NA	14	14
215-217.	Xylenes (total)	22	22	NA	22	22
57.	Anthracene	NA	28	NA	28	NA
59.	Benz(a)anthracene	NA	NA	NA	20	NA
62.	Benzo(a)pyrene	12	12	12	12	12
70.	Bis(2-ethylhexyl)phthalate	7.3	7.3	NA	7.3	NA
80.	Chrysene	15	15	NA	15	NA
81.	o-Cresol	NA	NA	NA	NA	6.2
82.	p-Cresol	NA	NA	NA	NA	6.2
98.	Di-n-butyl phthalate	3.6	NA	NA	3.6	NA
121.	Naphthalene	42	42	NA	42	42
141.	Phenanthrene	34	34	NA	34	34
142.	Phenol	3.6	3.6	3.6	3.6	3.6
145.	Pyrene	36	36	NA	36	NA

Maximum for any Single Grab Sample

	BDAT List Constituent	TCLP (mg/l) K048	K049	K050	K051	K052
164.	Nickel	0.20	0.20	0.20	0.20	0.20

NA - Not applicable.

Table 1-2

BDAT TREATMENT STANDARDS FOR
CYANIDE IN K048-K052
WASTEWATERS

Maximum for any Single Grab Sample

	BDAT List Constituent	Total Concentration (mg/l)				
		K048	K049	K050	K051	K052
169.	Cyanides (total)	0.028	0.028	0.028	0.028	0.028

2.0 AMENDMENT TO SECTION 2.2 (WASTE CHARACTERIZATION) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR K048-K052

This section supplements Section 2.2 of the Final BDAT Background Document for K048-K052 by presenting additional waste characterization data for K048, K049, K051, K052, and mixtures of K048-K052.

Additional characterization data were collected from an EPA-conducted treatment test and from data submitted to EPA subsequent to promulgation of the First Third rule as well as during the public comment period for the proposed Third Third rule. The Waste Characterization data tables have been revised by adding the additional data and are presented in their entirety in this document as Tables 2-1 through 2-5. Plant codes are listed in Appendix A. A summary of the additional columns for amended Tables 2-1 through 2-5 appears below:

Waste Code(s)	Table Number In This Document	Table Number in Final First Third Background Document	Additional Column(s)	Plant Code(s)	Source(s)
K048	2-1	2-4	(h)	R	Exxon
K049	2-2	2-5	(f)	R	Exxon
K049	2-2	2-5	(g)	T	CF Systems
K051	2-3	2-7	(i)	R	Exxon
K051	2-3	2-7	(j)	T	CF Systems
K052	2-4	2-8	(e)	R	Exxon
K048-K052*	2-5	2-9	(k)	T	CF Systems
K048-K052*	2-5	2-9	(l)	X	BP America
K048-K052*	2-5	2-9	(m)	U	Amoco
K048-K052*	2-5	2-9	(n)	R	Exxon

*Mixtures of K048-K052.

Table 2-1

AVAILABLE CHARACTERIZATION DATA FOR K048

		Concentration in Untreated Waste (ppm)								
	Source of Data:	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	Range
BDAT LIST ORGANICS										
Volatiles										
4.	Benzene	<14	---	---	---	---	---	13-16	<1.0	<1.0-16
21.	Dichlorodi-fluoromethane	<14-310	---	---	---	---	---	---	---	<14.0-310
226.	Ethyl benzene	<14-120	---	---	---	---	---	42-46	<1.0	<1.0-120
43.	Toluene	22-120	---	---	---	---	---	130-150	<1.0	<1.0-150
215-217.	Xylene (total)	<14-120	---	---	---	---	---	150-170	<4.1	<4.1-170
Semivolatiles										
62.	Benzo(a)pyrene	<20	0.004-1.75	---	---	---	---	---	<40	0.004-<40
70.	Bis(2-ethylhexyl) phthalate	<20-59	---	---	---	---	---	---	<40	<20.0-59
80.	Chrysene	<20-22	---	---	---	---	---	<0.66-59	<40	<0.66-59
98.	Di-n-butyl phthalate	67-190	---	---	---	---	---	---	<40	<40.0-190
109.	Fluorene	31-32	---	---	---	---	---	<0.66-58	---	<0.66-58
121.	Naphthalene	93-110	---	---	---	---	---	290-350	<40	<40-350
141.	Phenanthrene	77-86	---	---	---	---	---	160-190	<40	<40-190
142.	Phenol	<20	3.0-210	---	---	---	---	---	<40	3.0-210
145.	Pyrene	31-35	---	---	---	---	---	70-93	<40	31-93

(a) U.S. EPA, Amoco Onsite Engineering Report, February 29, 1988 (Reference 6).
(b) Jacobs Engineering Company, Assessment of Hazardous Waste Practices. 1976 (Reference 3).
(c) Delisting petition #386 (Reference 17).
(d) Delisting petition #469 (Reference 20).
(e) Delisting petition #421 (Reference 19).
(f) Delisting petition #396 (Reference 18).
(g) U.S. EPA, Amoco Onsite Engineering Report, July 15, 1988 (Reference 8).
(h) Exxon Company, U.S.A. 1989. Refinery Waste Solvent Tests (Reference 55).
--- Data are not available for this constituent.

Table 2-1 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K048

		Concentration in Untreated Waste (ppm)								
	Source of Data:	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	Range
BDAT METALS										
154.	Antimony	<6-7	---	---	---	---	---	4.4-5.0	---	4.4-7
155.	Arsenic	4.9-6.1	0.05-10.5	<3.0	---	---	---	2.9-3.9	---	0.05-10.5
156.	Barium	59-67	---	172-349	---	---	---	43.0-47.0	---	43.0-59
157.	Beryllium	<0.1	0.0012-0.25	---	---	---	---	0.79-0.84	---	0.0012-0.84
158.	Cadmium	0.4-0.7	---	<0.25	---	---	---	---	---	<0.25-0.7
159.	Chromium (total)	810-960	28-260	1,057-3,435	270-560	0.04-0.11	2.5-10.94	180.0-190.0	---	0.04-3,435
160.	Copper	47-56	0.05-21.3	---	---	---	---	27.0-30.0	---	0.05-56
161.	Lead	330-410	2.3-1,250	1.6-450	4.9-33	0.05-13.8	6.5-73	170-180	---	0.05-1,250
162.	Mercury	0.11-0.16	0.07-0.89	1-2	---	---	---	<0.05-0.26	---	<0.05-0.89

(a) U.S. EPA, Amoco Onsite Engineering Report, February 29, 1988 (Reference 6).
(b) Jacobs Engineering Company, Assessment of Hazardous Waste Practices. 1976 (Reference 3).
(c) Delisting petition #386 (Reference 17).
(d) Delisting petition #469 (Reference 20).
(e) Delisting petition #421 (Reference 19).
(f) Delisting petition #396 (Reference 18).
(g) U.S. EPA, Amoco Onsite Engineering Report, July 15, 1988 (Reference 8).
(h) Exxon Company, U.S.A. 1989. Refinery Waste Solvent Tests (Reference 55).
--- Data are not available for this constituent.

Table 2-2

AVAILABLE CHARACTERIZATION DATA FOR K049

		Concentration in Untreated Waste (ppm)							
	Source of Data:	(a)	(b)	(c)	(d)	(e)	(f)	(g)	Range
BDAT LIST ORGANICS									
Volatiles									
4.	Benzene	---	95	BDL-1600	---	---	100	5.6	BDL-1,600
8.	Carbon disulfide	---	BDL	0.15-0.96	---	---		---	BDL-0.96
226.	Ethyl benzene	---	120	---	---	---	160	---	120-160
43.	Toluene	---	210	240-18,000	---	---	1,300	28.9	28.9-18,000
215-217.	Xylene (total)	---	150	---	---	---	1,600	55.2	55.2-1,600
Semivolatiles									
57.	Anthracene	---	<40	BDL-58	---	---	<190	---	BDL-<190
62.	Benzo(a)pyrene	0.002-0.18	<40	---	---	---	<190	---	0.002-<190
70.	Bis(2-ethylhexyl) phthalate	---	<40	BDL-29	---	---	<190	<5.4	BDL-<190
80.	Chrysene	---	40	BDL-44	---	---	<190	---	BDL-<190
96.	2,4-Dimethylphenol	---	<40	BDL-3.3	---	---	---	---	BDL-3.3
98.	Di-n-butyl phthalate	---	---	---	---	---	<190	<5.4	<5.4-<190
121.	Naphthalene	---	<40	160-680	---	---	<340	15.8	15.8-680
141.	Phenanthrene	---	87	BDL-390	---	---	<190	9.8	BDL-390
142.	Phenol	5.7-127	<40	BDL-8.9	---	---	<190	---	BDL-<190
145.	Pyrene	---	<40	33-110	---	---	<190	4.5	4.5-<190

(a) Jacobs Engineering Company, Assessment of Hazardous Waste Practices, 1976 (Reference 3).
(b) U.S. EPA, Conoco Characterization Report, February 22, 1988 (Reference 13).
(c) Delisting petition #503 (Reference 14).
(d) API, Refinery Solid Waste Survey, 1983 (Reference 2).
(e) Delisting petitions #481, #386, #530, #264, #426, and #469 (References 21, 17, 23, 24, 25, and 20)
(f) Exxon Company, U.S.A. 1989 Plant R, Refinery Waste Solvent Tests (Reference 55).
(g) CF Systems. 1989. Plant T, Data Submitted to U.S. EPA (Reference 56).
BDL The compound was detected below the detection limit; the detection limit was not reported.
--- Data are not available for this constituent.

Table 2-2 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K049

Source of Data:	Concentration in Untreated Waste (ppm)							
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	Range
BDAT LIST METALS								
154. Antimony	---	<3.2	BDL-19	---	---	---	---	BDL-19
155. Arsenic	7.4	3.9	3-30	---	<2.2-9.6	---	---	<2.2-30
156. Barium	---	115	87-370	---	28-54.2	---	---	28-370
157. Beryllium	0.0025	<0.1	BDL-0.29	---	0.35	---	---	BDL-0.35
158. Cadmium	0.19	<0.4	0.7-4.4	---	28.8	---	---	0.19-28.8
159. Chromium (total)	525	134	150-1,400	476	28.9-512.5	---	---	28.9-1,400
221. Chromium (hexavalent)	---	<0.05	---	---	0.02-<1.9	---	---	0.02-<1.9
160. Copper	48	65.3	---	---	79.8	---	---	48-79.8
161. Lead	28.1	31.9	28-3,900	302	21.95-2146	---	---	21.95-3,900
162. Mercury	0.59	0.6	BDL-32	---	0.15	---	---	BDL-32
163. Nickel	50	9.2	20-86	---	50.62	---	---	9.2-86
164. Selenium	1.0	<5.0	BDL-4.6	---	<0.44-4.8	---	---	BDL-5.0
165. Silver	0.4	<0.6	---	---	<0.38-<4.0	---	---	<0.38-0.4
167. Vanadium	25	2.5	13-60	---	5.56	---	---	2.5-60
168. Zinc	250	142	---	---	72.8	---	---	72.8-250
BDAT LIST INORGANICS								
169. Cyanide	0.000012-52.5	<0.5	---	---	---	---	---	0.000012-52.5
170. Fluoride	---	1.31	---	---	---	---	---	1.31
171. ---	34.4	---	---	---	---	---	---	34.4
OTHER PARAMETERS								
BTU content (Btu/lb)	150*							
Filterable solids (%)	10+							
Oil and Grease content (%)	39+							
Water content (%)	50+							
pH (standard units)	7.4*							
TOX (%)	Negligible*							

(a) Jacobs Engineering Company, Assessment of Hazardous Waste Practices, 1976 (Reference 3).
(b) U.S. EPA, Conoco Characterization Report, February 22, 1988 (Reference 13).
(c) Delisting petition #503 (Reference 14).
(d) API, Refinery Solid Waste Survey, 1983 (Reference 2).
(e) Delisting petitions #481, #386, #530, #264, #426, and #469 (References 21, 17, 23, 24, 25, and 20)
(f) Exxon Company, U.S.A. 1989 Plant R, Refinery Waste Solvent Tests (Reference 55).
(g) CF Systems. 1989. Plant T, Data Submitted to U.S. EPA (Reference 56).
(*) Environ Corporation, Characterization of Listed Waste Streams (Reference 15).
(+) Calculations can be found in Appendix B of Final BDAT Background Document for K048-K052 (Reference 40).
BDL The compound was detected below the detection limit; the detection limit was not reported.
--- Data are not available for this constituent.

Table 2-3

AVAILABLE CHARACTERIZATION DATA FOR K051

	Concentration in Untreated Waste (ppm)										
Source of Data:	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	Range
BOAT LIST ORGANICS											
Volatiles											
4. Benzene	---	---	---	---	---	---	---	74	120	133.7-370	74.-370
226. Ethyl benzene	46-52	---	---	---	---	---	56	120	150	<0.3	<0.3-150
43. Toluene	33-71	---	---	---	---	---	170	450	750	59.4-390	33-450
215-217. Xylene (total)	71-83	---	---	---	---	---	390	720	880	1,066-1,160	71-1,160
Semivolatiles											
52. Acenaphthene	33	---	---	---	---	---	<10	---	---	---	<10-33
57. Anthracene	---	---	---	---	---	---	---	13	<200	667	13-667
59. Benz(a)anthracene	22-29	---	---	---	---	---	<10	13	<200	---	<10-<200
62. Benzo(a)pyrene	---	0.002-4.5	---	---	---	---	<10	7	<200	---	0.002-<200
70. Bis(2-ethylhexyl) phthalate	26-30	---	---	---	---	---	<10	---	<200	17.8	<10-<200
80. Chrysene	45-51	---	---	---	---	---	14	23	<200	17.7	14-<200
98. Di-n-butylphthalate	43-230	---	---	---	---	---	<10	---	<200	---	<10-230
109. Fluorene	33-37	---	---	---	---	---	11	---	---	---	11-37
121. Naphthalene	150-170	---	---	---	---	---	97	200	550	431	97-550
141. Phenanthrene	110-120	---	---	---	---	---	70	110	540	205-1,360	70-1,360
142. Phenol	<20	3.8-156.7	---	---	---	---	---	<2	<200	---	<2-<200
145. Pyrene	62-74	---	---	---	---	---	24	27	<200	30.4-<35	24-<200

(a) U.S. EPA, Amoco Onsite Engineering Report, February 29, 1988 (Reference 6).
(b) Jacobs Engineering Company, Assessment of Hazardous Waste Practices, 1976 (Reference 3).
(c) Delisting petition #481 (Reference 21).
(d) Delisting petition #386 (Reference 17).
(e) Delisting petition #205 (Reference 16).
(f) Delisting petition #469 (Reference 20).
(g) CF Systems Corporation, company literature, March 30, 1987 (Reference 30).
(h) The American Petroleum Institute, comments on land disposal restrictions, 1988 (Reference 26).
(i) Exxon Company, U.S.A. 1989. Plant R, Refinery Waste Solvent Tests (Reference 55).
(j) CF Systems. 1989. Plant T, data submitted to U.S. EPA (Reference 56).
--- Data are not available for this constituent.

Table 2-3 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K051

	Concentration in Untreated Waste (ppm)										
Source of Data:	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	Range
BDAT LIST METALS											
154. Antimony	9-18	---	---	---	---	---	---	---	---	---	9-18
155. Arsenic	5.4-9.7	0.1-32	---	---	<3.0	---	---	5.6	---	---	0.1-32
156. Barium	72-120	---	---	---	188-412	---	---	68	---	---	68-412
157. Beryllium	<0.1	0.0012-0.24	---	---	---	---	---	---	---	---	0.0012-0.24
158. Cadmium	1.3-1.7	0.024-3.0	---	---	<0.25	---	---	<0.5	---	---	0.024-3.0
159. Chromium (total)	730-1,100	0.1-6,790	800-3,220	150-875	535-3,679	160-740	---	80	---	---	0.1-6,790
221. Chromium (hexavalent)	22[@]	---	<1.0	0.010-0.036	---	---	---	---	---	---	0.01-22
160. Copper	130-170	2.5-550	---	---	---	---	---	---	---	---	2.5-550
161. Lead	640-940	0.25-1,290	2,120-2,480	9.5-23.3	53-173	7.7-740	---	64	---	---	0.25-2,480
162. Mercury	0.07-0.31	0.04-6.2	---	---	3.0	---	---	4.4	---	---	0.04-6.2
163. Nickel	30-37	0.25-150.4	---	---	---	---	---	---	---	---	0.25-150.4
164. Selenium	0.5-1.6	0.005-7.6	---	---	2-12	---	<0.2	1.6	---	---	0.005-12
165. Silver	1.4	0.05-3	---	---	<0.3	---	---	<0.3	---	---	0.05-3
167. Vanadium	260-350	1-48.5	---	---	---	---	---	---	---	---	1-350
168. Zinc	570-820	25-6,596	---	---	---	---	---	---	---	---	25-6,596
BDAT LIST INORGANICS											
169. Cyanide	0.5-1.4	0.00006-51.4	---	---	---	---	<0.5	---	---	---	0.00006-51.4
171. Sulfide	2,900-4,800	---	---	---	---	---	120	---	---	---	120-4,800
OTHER PARAMETERS											
Filterable solids (%)	16[+]						3.9				
Oil and Grease Content	13[+]						4.5				
Water Content	70[+]						91.4				

(a) U.S. EPA, Amoco Onsite Engineering Report, February 29, 1988 (Reference 6).
(b) Jacobs Engineering Company, Assessment of Hazardous Waste Practices, 1976 (Reference 3).
(c) Delisting petition #481 (Reference 21).
(d) Delisting petition #386 (Reference 17).
(e) Delisting petition #205 (Reference 16).
(f) Delisting petition #469 (Reference 20).
(g) CF Systems Corporation, company literature, March 30, 1987 (Reference 30).
(h) The American Petroleum Institute, comments on land disposal restrictions, 1988 (Reference 26).
(i) Exxon Company, U.S.A. 1989. Plant R, Refinery Waste Solvent Tests (Reference 55).
(j) CF Systems. 1989. Plant T, data submitted to U.S. EPA (Reference 56).
@ Colorimetric interference may have occurred in analysis of this sample.
(+) Calculations can be found in Appendix B of Final BDAT Background Document for K048-K052 (Reference 40).
--- Data are not available for this constituent.

Table 2-4

AVAILABLE CHARACTERIZATION DATA FOR K052

Source of Data:	Concentration in Untreated Waste (ppm) (a)	(b)	(c)	(d)	(e)	Range
BDAT LIST ORGANICS						
4. Benzene	650	---	---	---	<5.0	<5.0-650
226. Ethyl benzene phthalate	2,300	---	---	---	8.6	8.6-2,300
43. Toluene	6,400	---	---	---	5.7	5.7-6,400
215-217. Xylene (total)	3,500	---	---	---	31.0	31.0-3,500
Semivolatiles						
62. Benzo(a)pyrene	<1.8	---	0.02-0.4	---	<33.0	0.02-<33
81. o-Cresol	13	---	---	---	<33.0	13-<33
82. p-Cresol	13	---	---	---	<33.0	13-<33
96. 2,4-Dimethylphenol	4.2	---	---	---	---	4.2
121. Naphthalene	13	---	---	---	<33.0	13-<33.0
141. Phenanthrene	1.4	---	---	---	95.0	1.4-95
142. Phenol	<1.8	---	2.1-250	---	<33.0	<1.8-250
145. Pyrene	---	---	---	---	43.0	43
BDAT LIST METALS						
154. Antimony	111	---	---	---	---	111
155. Arsenic	242	---	63-525	---	---	63-525

(a) U.S. EPA, Conoco Characterization Report, February 22, 1988 (Reference 13).
(b) API, Refinery Solid Waste Survey, 1983 (Reference 2).
(c) Jacobs Engineering Company, Assessment of Hazardous Waste Practices, 1976 (Reference 3).
(d) Delisting petition #386 (Reference 17).
(e) Exxon Company, U.S.A. 1989. Plant R, Refinery Waste Solvent Tests (Reference 55).
--- Data are not available for this constituent.

Table 2-4 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K052

Source of Data:	Concentration in Untreated Waste (ppm) (a)	(b)	(c)	(d)	(e)	Range
BDAT LIST METALS (Cont.)						
156. Barium	8	---	---	---	---	8
157. Beryllium	<0.1	---	0.0025	---	---	0.0025-<0.1
158. Cadmium	0.82	---	4.5-8.1	---	---	0.82-8.1
159. Chromium (total)	48.8	1.0-504	9.0-13.7	---	---	1.0-504
160. Copper	146	---	110-172	---	---	110-172
161. Lead	99.4	11.0-5,800	158-1,421	42-2,060	---	11-5,800
162. Mercury	2.4	---	0.19-0.94	---	---	0.19-2.4
163. Nickel	97.2	---	235-392	---	---	97.2-392
164. Selenium	<100	---	3.1-10.8	---	---	3.1-<100
165. Silver	<6.0	---	0.05-1.7	---	---	0.05-<6.0
167. Vanadium	<6.0	---	1.0-9.8	---	---	1.0-9.8
168. Zinc	17.1	---	1,183-17,000	---	---	17.1-17,000
BDAT LIST ORGANICS						
169. Cyanide	1.89	---	---	---	---	1.89
170. Fluoride	955	---	---	---	---	955
171. Sulfide	111	---	---	---	---	111
OTHER PARAMETERS						
Filterable solids (%)	68+					
Oil and grease content (%)	13+					
Water content (%)	18+					

(a) U.S. EPA, Conoco Characterization Report, February 22, 1988 (Reference 13).
(b) API, Refinery Solid Waste Survey, 1983 (Reference 2).
(c) Jacobs Engineering Company, Assessment of Hazardous Waste Practices, 1976 (Reference 3).
(d) Delisting petition #386 (Reference 17).
(e) Exxon Company, U.S.A. 1989. Plant R, Refinery Waste Solvent Tests (Reference 55).
(+) Calculations can be found in Appendix B of Final BDAT Background Document for K048-K052 (Reference 40).
--- Data are not available for this constituent.

Table 2-5

AVAILABLE CHARACTERIZATION DATA FOR K048-K052 MIXTURES

BDAT LIST ORGANICS	Concentration in Untreated Waste (ppm)						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Volatiles							
222. Acetone	---	---	---	---	---	---	---
4. Benzene	86-190	---	2,100	530	9.8	600	80
226. Ethylbenzene	76-120	---	1,300	1,100	17	---	86
43. Toluene	230-470	---	6,300	1,500	68	6,600	340
45. 1,1,1-Trichloroethane	---	---	---	---	---	---	---
215-217. Xylenes (total)	420-570	---	5,900	4,000	106	8,880	430
Semivolatiles							
57. Anthracene	---	---	22	29	0.069	<46	13.3
59. Benz(a)anthracene	<20-21	---	17	18	0.14	---	3.4
62. Benzo(a)pyrene	<19-<21	---	9.4	11	0.071	---	1.8
63. Benzo(b) Fluoranthene	---	---	6.3	8	0.041	---	1.2
70. Bis(2-ethylhexyl) phthalate	<19-<21	<3-49	4.2	<2	<0.009	---	---
80. Chrysene	<20-33	4.7-<7	19	30	0.24	---	9.4
81. o-Cresol	---	---	<2	<2	0.33	<19	0.4
82. p-Cresol	---	---	<2	<2	0.42	---	1.3
83. Dibenz(a,h)anthracene	---	---	3.9	<2	<0.009	---	1.1
87. 1,2-Dichlorobenzene	<19-<21	<3-3.3	---	---	---	---	---
96. 2,4-Dimethylphenol	---	<3-<7	<10	<2	<0.009	---	0.7
108. Fluoranthene	<19-<21	<3-3.7	9.2	10	0.55	---	<1
109. Fluorene	---	3.4-<7	---	---	---	---	---
121. Naphthalene	56-140	22-30	180	490	1.1	560	82
141. Phenanthrene	64-140	13-17	240	210	0.53	740	109
142. Phenol	---	<3-<7	<2	<2	1.7	<1,900	0.9
145. Pyrene	<20-36	<3-3.6	59	95	0.25	---	26
52. Acenaphthene	---	---	---	---	---	---	---
64. Benzo(g,h,i)perylene	---	---	---	---	---	---	---

(a) K048-K052 mixture of refinery wastes: BP America, Inc. comments on land disposal restrictions, 1988 (Reference 36).
(b) Mixture of K049-K051: Resources Conservation Company, comments on land disposal restrictions, 1988 (Reference 37).
(c) Unspecified mixture of refinery wastes: Plant C, API comments on land disposal restrictions, 1987 (Reference 26).
(d) Mixture of K048, K049, and K051: Plant D, API, comments on land disposal restrictions, 1987 (Reference 26).
(e) Mixture of K051 and K052: Plant E, API, comments on land disposal restrictions, 1987 (Reference 26).
(f) Mixture of K049 and K051: Plant F, API, comments on land disposal restrictions, 1987 (Reference 26).
(g) Unspecified mixture of refinery wastes: Plant H, API, comments on land disposal restrictions, 1987 (Reference 26).
--- Data not available for this constituent.

Table 2-5 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K048-K052 MIXTURES

BOAT LIST ORGANICS		Concentration in Untreated Waste (ppm)							
		(h)	(i)	(j)	(k)	(l)	(m)	(n)	Range*
Volatiles									
222.	Acetone	---	---	12-61	---	---	---	---	12-61
4.	Benzene	60	---	8.5-18	5.1-13.7	---	---	---	5.1-2,100
226.	Ethylbenzene	110	22	28-64	0.5-67	---	---	---	0.5-2,100
43.	Toluene	360	40	64-150	0.7-54.0	---	---	---	0.7-6,600
45.	1,1,1-Trichloroethane	---	381	---	---	---	---	---	381
215-217.	Xylenes (total)	690	104	130-240	0.9-78.0	---	---	---	0.9-8,880
Semivolatiles									
57.	Anthracene	9.4	---	3.4	86.0-351.0	---	---	---	0.069-351.0
59.	Benz(a)anthracene	20	22	6.2-6.8	---	---	---	---	0.14-22
62.	Benzo(a)pyrene	9.9	---	2.3-3.5	---	---	---	---	0.71-11
63.	Benzo(b) Fluoranthene	6.2	---	1.7	---	---	---	---	0.41-8.0
70.	Bis(2-ethylhexyl)phthalate	<1	---	---	---	---	---	---	1.1-49
80.	Chrysene	26	42	9.4-12.2	---	---	---	---	0.24-42
81.	o-Cresol	<1	---	---	---	---	---	---	0.33-0.4
82.	p-Cresol	<1	---	3-7.9#	---	---	---	---	0.42-1.3
83.	Dibenz(a,h)anthracene	<1	---	---	---	---	---	---	1.1-3.9
87.	1,2-Dichlorobenzene	---	---	---	---	---	---	---	3.3
96.	2,4-Dimethylphenol	<1	---	---	---	---	---	---	0.7
108.	Fluoranthene	5.9	---	1.7-3.1	---	---	---	---	0.055-10
109.	Fluorene	---	---	11.6-18.9	---	---	---	---	3.4-18.9
121.	Naphthalene	90	110	41.6-54	18.6-50.0	---	---	---	1.1-560
141.	Phenanthrene	47	86	37.7-54.3	18.6-94.0	---	---	---	0.53-740
142.	Phenol	<1	---	2.1-9.4	---	---	---	---	0.0-9.4
145.	Pyrene	22	39	11-13.7	<35-350.0	---	---	---	0.25-350
52.	Acenaphthene	---	---	2.2-5.5	---	---	---	---	2.2-5.5
64.	Benzo(g,h,i)perylene	---	---	1.52	---	---	---	---	1.52

(h) Mixture of K051-K052: Plant H, API, comments on land disposal restrictions, 1987 (Reference 26).
(i) Mixture of K048 and K051: Characterization Report for K048 and K051, Amoco Oil Company, Whiting, IN, 1989 (Reference 42).
(j) Mixture of K048 and K051: Plant Q, Onsite Engineering Report of Treatment Technology Performance and Operation for CF Systems, Waltham, MA, 1989 (Reference 43).
(k) K048-K052 Mixture: Plant T, CF Systems data submitted to U.S. EPA, 1989 (Reference 56).
(l) K048-K052 Mixture: Plant X, BP America. 1989 (Reference 50).
(m) K048 and K051 Mixture: Plant U, Amoco Corporation. Comments on land disposal restrictions, 1989 (Reference 52).
(n) K049 and K051 Mixture: Plant R, Exxon Company, U.S.A. 1989 (Reference 55).
* Values less than detection limit are not included in the range of concentrations.
\# Due to chromatographic coelution, p-Cresol and m-Cresol have been reported as total m- and p-Cresol. This result is not included in the ranges of concentrations.
--- Data not available for this constituent.

Table 2-5 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K048-K052 MIXTURES

		Concentration in Untreated Waste (ppm)						
		(a)	(b)	(c)	(d)	(e)	(f)	(g)
BDAT List Metals								
154.	Antimony	---	---	---	---	---	---	---
155.	Arsenic	---	---	<0.2	1.2	0.8	---	2.0
156.	Barium	---	0.13-0.62	120	21	54	---	115
158.	Cadmium	---	---	<0.5	<0.5	<0.5	---	<2
159.	Chromium (total)	---	0.07-0.09	150	150	328	220	340
160.	Copper	---	---	---	---	---	---	---
161.	Lead	---	4.2-5.1	30	8.2	48	27	40
162.	Mercury	---	<0.001	0.09	<0.05	0.13	---	0.2
163.	Nickel	---	---	7	---	---	---	---
164.	Selenium	---	---	---	---	---	---	---
167.	Vanadium	---	---	2.7	---	---	---	---
168.	Zinc	---	11-16	---	---	---	---	---
Inorganics								
169.	Cyanide	---	---	---	---	---	---	---
170.	Sulfide	---	---	---	---	---	---	---
171.	Fluoride	---	---	---	---	---	---	---
BDAT List Organics PCBs								
203.	Aroclor 1242	---	1.3-8.7	---	---	---	---	---
206.	Aroclor 1260	---	0.55-3.5	---	---	---	---	---
Dioxins								
212.	Tetrachloro-dibenzofuran	---	---	---	---	---	---	---

(a) K048-K052 mixture of refinery wastes: BP America, Inc. comments on land disposal restrictions, 1988 (Reference 36).
(b) Mixture of K049-K051: Resources Conservation Company, comments on land disposal restrictions, 1988 (Reference 37).
(c) Unspecified mixture of refinery wastes: Plant C, API comments on land disposal restrictions, 1987 (Reference 26).
(d) Mixture of K048, K049, and K051: Plant D, API, comments on land disposal restrictions, 1987 (Reference 26).
(e) Mixture of K051 and K052: Plant E, API, comments on land disposal restrictions, 1987 (Reference 26).
(f) Mixture of K049 and K051: Plant F, API, comments on land disposal restrictions, 1987 (Reference 26).
(g) Unspecified mixture of refinery wastes: Plant H, API, comments on land disposal restrictions, 1987 (Reference 26).
--- Data not available for this constituent.

Table 2-5 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K048-K052 MIXTURES

BDAT List Metals		Concentration in Untreated Waste (ppm)							
		(h)	(i)	(j)	(k)	(l)	(m)	(n)	Range*
154.	Antimony	---	8.7	5.8	---	---	---	---	5.8-8.7
155.	Arsenic	7.0	1.5	3.6-4.0	---	---	0.171	0.007-0.11	0.007-7
156.	Barium	142	63	16-70	---	---	---	---	0.13-142
158.	Cadmium	1	1	0.55-0.73	---	---	---	---	0.55-1
159.	Chromium (total)	835	119	24-225	---	0.07-0.26	1.13	0.11-0.44	0.07-835
160.	Copper	---	73	14-108	---	---	---	---	14-108
161.	Lead	126	183	30-160	---	---	---	---	4.2-160
162.	Mercury	2.9	3.1	0.38-2.6	---	---	---	---	0.09-3.1
163.	Nickel	---	36	6.8-19	---	0.21-0.27	0.324	0.15-0.17	0.15-36
164.	Selenium	---	1.2	0.75-5.3	---	---	---	---	0.75-5.3
167.	Vanadium	---	118	26-147	---	---	---	---	2.7-147
168.	Zinc	---	295	69-294	---	---	---	---	11-295
Inorganics									
169.	Cyanide	---	0.60	---	---	---	---	---	0.60
170.	Sulfide	---	464	102	---	---	---	---	102-464
171.	Fluoride	---	0.47	---	---	---	---	---	0.47
BDAT List Organics PCBs									
203.	Aroclor 1242	---	---	---	---	---	---	---	1.3-8.7
206.	Aroclor 1260	---	---	---	---	---	---	---	0.55-3.5
Dioxins									
212.	Tetrachloro-dibenzofuran	---	---	0.0013	---	---	---	---	0.0013

(h) Mixture of K051-K052: Plant H, API, comments on land disposal restrictions, 1987 (Reference 26).
(i) Mixture of K048 and K051: Characterization Report for K048 and K051, Amoco Oil Company, Whiting, IN, 1989 (Reference 42).
(j) Mixture of K048 and K051: Plant Q, Onsite Engineering Report of Treatment Technology Performance and Operation for CF Systems, Waltham, MA, 1989 (Reference 43).
(k) K048-K052 Mixture: Plant T, CF Systems data submitted to U.S. EPA, 1989 (Reference 56).
(l) K048-K052 Mixture: Plant X, BP America. 1989 (Reference 50).
(m) K048 and K051 Mixture: Plant U, Amoco Corporation. Comments on land disposal restrictions, 1989 (Reference 52).
(n) K049 and K051 Mixture: Plant R, Exxon Company, U.S.A. 1989 (Reference 55).
* Values less than detection limit are not included in the range of concentrations.
--- Data not available for this constituent.

Table 2-5 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K048-K052 MIXTURES

BDAT LIST ORGANICS	Concentration in Untreated Waste (ppm)						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
General Constituents							
Oil and Grease (mg/kg)	1.1-37.7	---	---	---	---	---	---
Water (%)	54.5-90.5	---	---	---	---	---	---
Total Solids	1.1-8.4	---	---	---	---	---	---
Ash Content (%)	---	---	---	---	---	---	---
Total Organic Carbon (mg/kg)	---	---	---	---	---	---	---
Total Halogen (mg/kg)	---	---	---	---	---	---	---
Density (g/ml)	---	---	---	---	---	---	---
Total Chloride	---	---	---	---	---	---	---
Particle Size Distribution (%)							
>2-<4.75 mm	---	---	---	---	---	---	---
>0.075-<0.425 mm	---	---	---	---	---	---	---
>0.005-<0.075 mm	---	---	---	---	---	---	---
<0.005	---	---	---	---	---	---	---
Flash point (°F)	---	---	---	---	---	---	---

(a) K048-K052 mixture of refinery wastes: BP America, Inc. comments on land disposal restrictions, 1988 (Reference 36).
(b) Mixture of K049-K051: Resources Conservation Company, comments on land disposal restrictions, 1988 (Reference 37).
(c) Unspecified mixture of refinery wastes: Plant C, API comments on land disposal restrictions, 1987 (Reference 26).
(d) Mixture of K048, K049, and K051: Plant D, API, comments on land disposal restrictions, 1987 (Reference 26).
(e) Mixture of K051 and K052: Plant E, API, comments on land disposal restrictions, 1987 (Reference 26).
(f) Mixture of K049 and K051: Plant F, API, comments on land disposal restrictions, 1987 (Reference 26).
(g) Unspecified mixture of refinery wastes: Plant H, API, comments on land disposal restrictions, 1987 (Reference 26).
--- Data not available for this constituent.

Table 2-5 (Continued)

AVAILABLE CHARACTERIZATION DATA FOR K048-K052 MIXTURES

General Constituents	Concentration in Untreated Waste (ppm)							
	(h)	(i)	(j)	(k)	(l)	(m)	(n)	Range
Oil and Grease (mg/kg)	---	11.3	76,900-109,000	---	---	---	---	1.1-109,000
Water (%)	---	61.9	67.8	---	---	---	---	54.5-90.5
Total Solids	---	26.3	27.1-42.9	---	---	---	---	1.1-42.9
Ash Content (%)	---	20.2	14.3	---	---	---	---	14.3 20.2
Total Organic Carbon (mg/kg)	---	---	72,100	---	---	---	---	72,100
Total Halogen (mg/kg)	---	395	60.5	---	---	---	---	60.5-395
Density (g/ml)	---	1.142	1.1	---	---	---	---	1.1-1.142
Total Chloride	---	73.3	34.2	---	---	---	---	34.2-73.3
Particle Size Distribution (%)								
>2-<4.75 mm	---	---	0.01	---	---	---	---	0.01
>0.075-<0.425 mm	---	---	44.4	---	---	---	---	44.4
>0.005-<0.075 mm	---	---	49.4	---	---	---	---	49.5
<0.005	---	---	6.25	---	---	---	---	6.25
Flash point (°F)	---	126	---	---	---	---	---	126

(h) Mixture of K049-K051: Plant H, API, comments on land disposal restrictions, 1987 (Reference 26).
(i) Mixture of K048 and K051: Characterization Report for K048 and K051, Amoco Oil Company, Whiting, IN, 1989 (Reference 42).
(j) Mixture of K048 and K051: Plant Q, Onsite Engineering Report of Treatment Technology Performance and Operation for CF Systems, Waltham, MA, 1989 (Reference 43).
(k) K048-K052 Mixture: Plant T, CF Systems, data submitted to U.S. EPA, 1989 (Reference 56).
(l) K048-K052 Mixture: Plant X, BP America. 1989 (Reference 50).
(m) K048 and K051 Mixture: Plant U, Amoco Corporation. Comments on land disposal restrictions, 1989 (Reference 52).
(n) K049 and K051 Mixture: Plant R, Exxon Company, U.S.A. 1989 (Reference 55).
--- Data not available for this constituent.

3.0 AMENDMENT TO SECTION 4.0 (PERFORMANCE DATA BASE) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR K048-K052

This section supplements Section 4.0 of the Final BDAT Background Document for K048-K052. This section presents treatment performance data that were considered by EPA in developing the revised treatment standards being promulgated for organic and metal constituents in K048-K052 nonwastewaters and for cyanide in K048-K052 wastewaters. For organic constituents in K048-K052 nonwastewaters, the Agency received additional solvent extraction data from eight sources and high temperature distillation data from one source. For metal constituents in K048-K052 nonwastewaters, the Agency received data for stabilization of solvent extraction raffinate from two sources, additional data for stabilization of fluidized-bed incinerator ash from one source, and data for stabilization of combustion gas scrubber water solids from one source. For cyanide in K048-K052 wastewaters, the Agency analyzed incineration data from one source.

The Agency's data quality screening criteria for data received include: (1) whether the data are from a demonstrated and available technology; (2) whether the treatment system was well-designed and well-operated; (3) whether adequate analytical quality assurance and quality control protocols were followed; (4) whether all candidate data sets used measures of performance consistent with those being used to set the treatment standards (e.g. total composition analysis for organic constituents in nonwastewaters and analysis of the Toxicity Characteristic Leaching Procedure (TCLP) extract for metal constituents in nonwastewaters); and (5) whether the data sets show substantial treatment on a constituent-by-constituent basis.

Plant codes and their references are listed in Appendix A.

3.1 Treatment Performance Data Base for Organics in Nonwastewaters

For organic constituents in K048-K052 nonwastewaters, the Agency received the following additional treatment data:

- Solvent extraction data from eight sources; and
- High temperature distillation data from one source.

After evaluating all the additional data sets based on the data quality screening criteria, data from three sources, Plants Q, R, and T, were considered for revising the treatment standards for organic constituents. These data were used in addition to the data from Plant A, which is included in the Final BDAT Background Document for K048-K052. From Plant Q, four sample sets of data from solvent extraction treatment (using CF Systems' solvent extraction unit - 5 passes) followed by centrifugation of a 50:50 mixture of K048 and K051 were considered for revision of the treatment standards and are shown in Table 3-1. (Detection limits for the untreated and treated wastes from Plant Q are presented in Appendix D.) Design and operating parameters for Plant Q are shown in Table 3-2. The Agency believes the solvent extraction unit at Plant Q was well-designed and well-operated during the treatment test. From Plant R, four sample sets of data from solvent extraction treatment (using CF Systems' solvent extraction unit - 3 passes) of K048, K049, K051, and K052 were considered and are shown in Table 3-3. Twelve sample sets of data from solvent extraction treatment (using CF Systems' solvent extraction unit - 3 passes) of K049, K051, and mixtures of K048-K052 were considered from Plant T and are shown in Table 3-4. Design and operating parameters from Plants R and T are not available. However, these treatment data were generated using the same technology (CF Systems' solvent extraction technology) that was used at Plant Q, and the Agency has data indicating that this technology is well-designed and well-operated (see Table 3-2).

Data submitted from six additional sources, Plants S, U, V, W, X, and Y did not meet the screening criteria and were rejected from further consideration. Also, twelve sample sets of data from Plant R and six sample

sets of data from Plant T were rejected from consideration. The reasons for rejecting these data are explained in Table 3-11.

3.2 Treatment Performance Data Base for Metals in Nonwastewaters

For metal constituents in K048-K052 nonwastewaters, the Agency received the following additional data:

- Stabilization of solvent extraction residual from two sources;
- Stabilization of fluidized-bed incinerator ash from one source; and
- Stabilization of combustion gas scrubber water solids from one source.

After evaluating all the additional data sets based on the data quality screening criteria, data from three sources, Plants R, U, and X, were considered for revising the treatment standards for metals. These data were considered along with the Agency-generated data from Plant I, which are included in the Final BDAT Background Document for K048-K052. The additional data sets include:

- Two sample sets of data from stabilization of solvent extraction residual (residual generated from BP America's multi-cycle solvent extraction unit) from treatment of a K049 and K051 mixture (unknown mixture of commercially available binders) from Plant R as shown in Table 3-5;
- Thirteen sample sets from stabilization of fluidized-bed incinerator ash (ash generated from Amoco's Whiting, IN fluidized-bed incinerator) from treatment of a 50:50 mixture of K048 and K051 (nine treated with a lime/flyash binder and four treated with a lime/flyash/C/F binder) were considered from Plant U, as shown in Table 3-6; and
- Four sample sets of data from stabilization of solvent extraction residual (residual generated from BP America's multi-cycle solvent extraction unit) from treatment of a K048-K052 mixture (unknown mixture of commercially available binders) from Plant X as shown in Table 3-7.

Available design and operating parameters for the stabilization process at Plant X are shown in Table 3-8. The Agency believes the stabilization process at Plant X was well-designed and well-operated. Design and operating parameters from Plants R and U are not available; however, the Agency has no reason to believe the stabilization processes used to generate these data were not well-designed and well-operated.

The majority of the stabilization data submitted by industry could not be considered for this rulemaking. The number of sample sets and reasons for rejecting each of these sample sets are explained in Table 3-12.

3.3 Treatment Performance Data Base for Wastewaters

For cyanide in K048-K052 wastewaters, the Agency analyzed performance data from the EPA-conducted test of fluidized-bed incineration (using Amoco's Whiting, IN fluidized-bed incinerator) of K048 at Plant A. The data shown in Table 3-9 are for cyanide in six sample sets of untreated K048 and combustion gas scrubber water samples. Design and operating parameters for the fluidized-bed incinerator are shown in Table 3-10. As discussed in the Final BDAT Background Document for K048-K052, the Agency believes that the incinerator at Plant A was well-designed and well-operated.

The Agency also has treatment performance data from the Industrial Technology Division (ITD) of the Agency's Office of Water for cyanide oxidation treatment of metal finishing wastewaters containing cyanide. These data are presented in EPA's Final Best Demonstrated Available Technology (BDAT) Background Document for U and P Wastes and Multi-Source Leachate (F039), Volume A.

Table 3-1

PERFORMANCE DATA COLLECTED BY EPA FOR TREATMENT OF K048 AND K051 AT PLANT Q -SOLVENT EXTRACTION FOLLOWED BY CENTRIFUGATION

Regulated BDAT List Constituents	Sample Set	UNTREATED WASTE		TREATED WASTE	
		Detection Limit (mg/kg)	Concentration in K048 and K051 Mixture (mg/kg)	Detection Limit (mg/kg)	Concentration in Raffinate Solids (mg/kg)
Volatile Organics					
4. Benzene	1	2.5	8.5	0.05	0.22
	2	5	12	0.05	0.09
	3	5	18	0.05	0.13
	4	3.1	9.2	0.05	0.1
226. Ethylbenzene	1	2.5	37	0.05	0.06
	2	5	30	0.05	<0.05
	3	5	64	0.05	<0.05
	4	3.1	28	0.05	<0.05
43. Toluene	1	2.5	73	0.05	0.94
	2	5	67	0.05	0.37
	3	5	150	0.05	0.45
	4	3.1	64	0.05	0.27
215 - 217. Xylenes (total)	1	2.5	150	0.05	0.19
	2	5	150	0.05	0.09
	3	5	240	0.05	0.09
	4	3.1	130	0.05	0.09
Semivolatile Organics					
57. Anthracene	1	1.36	<1.36	0.33	<0.33
	2	1.28	<1.28	0.33	<0.33
	3	2.72	3.4	0.33	<0.33
	4	1.36	4.36	0.33	<0.33
59. Benz(a)anthracene	1	1.36	<1.36	0.33	<0.33
	2	1.28	6.2	0.33	<0.33
	3	2.72	6.8	0.33	<0.33
	4	1.36	6.7	0.33	<0.33
62. Benzo(a)pyrene	1	1.36	3.5	0.33	<0.33
	2	1.28	2.3	0.33	<0.33
	3	2.72	<2.72	0.33	<0.33
	4	1.36	2.4	0.33	<0.33
70. Bis(2-ethylhexyl)phthalate	1	1.36	<1.36	0.33	<0.33
	2	1.28	<1.28	0.33	<0.33
	3	2.72	<2.72	0.33	<0.33
	4	1.36	<1.36	0.33	<0.33
80. Chrysene	1	1.36	11.6	0.33	0.42
	2	1.28	12.2	0.33	<0.33
	3	2.72	11.9	0.33	<0.33
	4	1.36	9.4	0.33	<0.33
81. o-Cresol	1	1.36	<1.36	0.33	<0.33
	2	1.28	<1.28	0.33	<0.33
	3	2.72	<2.72	0.33	<0.33
	4	1.36	<1.36	0.33	<0.33
82. p-Cresol	1	1.36	7	0.33	2.6
	2	1.28	3.9	0.33	1.9
	3	2.72	3	0.33	2.3
	4	1.36	7.9	0.33	1.1

Source: CF Systems' Onsite Engineering Report (Reference 43).

Table 3-1 (Continued)

PERFORMANCE DATA COLLECTED BY EPA FOR TREATMENT OF K048 AND K051 AT PLANT Q -SOLVENT EXTRACTION FOLLOWED BY CENTRIFUGATION

Regulated BDAT List Constituents	Sample Set	UNTREATED WASTE		TREATED WASTE	
		Detection Limit (mg/kg)	Concentration in K048 and K051 Mixture (mg/kg)	Detection Limit (mg/kg)	Concentration in Raffinate Solids (mg/kg)
Semivolatile Organics (Continued)					
98. Di-n-butyl phthalate	1	1.36	<1.36	0.33	<0.33
	2	1.28	<1.28	0.33	<0.33
	3	2.72	<2.72	0.33	<0.33
	4	1.36	<1.36	0.33	<0.33
121. Naphthalene	1	1.36	54	0.33	0.38
	2	1.28	44	0.33	<0.33
	3	2.72	41.6	0.33	<0.33
	4	1.36	51.5	0.33	<0.33
141. Phenanthrene	1	1.36	42.4	0.33	0.46
	2	1.28	43.8	0.33	0.4
	3	2.72	54.3	0.33	<0.33
	4	1.36	37.7	0.33	0.35
142. Phenol	1	1.36	5.2	0.33	1.1
	2	1.28	2.1	0.33	1.2
	3	2.72	<2.72	0.33	1.8
	4	1.36	9.4	0.33	0.74
145. Pyrene	1	1.36	13	0.33	0.67
	2	1.28	12.3	0.33	<0.33
	3	2.72	13.7	0.33	<0.33
	4	1.36	11	0.33	0.48

Source: CF Systems Onsite Engineering Report (Reference 43).

Table 3-2

DESIGN AND OPERATING PARAMETERS FOR THE
SOLVENT EXTRACTION UNIT AND CENTRIFUGE AT PLANT Q

Solvent Extraction Unit

Physical Design Parameters	Values or Description
Number of Stages per Pass	2
Number of Passes	5
Total Number of Stages	10
Extractor 1:	
Pressure (psig)	235-270
Temperature (deg F)	68-90
Extractor 2:	
Pressure (psig)	210-255
Temperature (deg F)	72-94
Mixer Speeds (rpm)	1,200

Centrifuge

Physical Design Parameters	Values or Description
Manufacturer	Sharples Model P660 Super-D-Canter Centrifuge
Power Supply	460V, 3 Phase, 60 Cycle. Can be adjusted to 220V
Maximum Variable Speed Back Drive (rpm)	6,000
Bowl Speed (rpm)	4,930
Conveyor Speed (rpm)	2,756
Belt Tension	9.5

Source: CF Systems Onsite Engineering Report (Reference 43).

Table 3-3

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K048, K049, K051, AND K052
AT PLANT R - SOLVENT EXTRACTION

Regulated BDAT List Constituents	UNTREATED WASTE				TREATED WASTE			
	K048 Concentration (mg/kg)	K049 Concentration (mg/kg)	K051 Concentration (mg/kg)	K052 Concentration (mg/kg)	K048 Raffinate Solids Concentration (mg/kg)	K049 Raffinate Solids Concentration (mg/kg)	K051 Raffinate Solids Concentration (mg/kg)	K052 Raffinate Solids Concentration (mg/kg)
Volatile Organics								
4. Benzene	<1.0	100	120	<5.0	<0.65	<5.0	<1.0	<0.5
226. Ethylbenzene	<1.0	160	150	8.6	<0.65	<5.0	<1.0	<0.5
43. Toluene	<1.0	1300	750	5.7	<0.65	<5.0	2.0	0.5
215 - 217. Xylenes (total)	<4.1	1600	880	31.0	1.2	7.9	4.1	0.5
Semivolatile Organics								
57. Anthracene	<40	<190	<200	<33.0	1.5	<1.3	7.8	7.6
59. Benz(a)anthracene	<40	<190	<200	<33.0	1.6	<1.3	7.2	6.8
62. Benzo(a)pyrene	<40	<190	<200	<33.0	1.7	<1.3	4.3	3.9
70. Bis(2-ethylhexyl)phthalate	<40	<190	<200	<33.0	<0.99	<1.3	2.61	2.5
80. Chrysene	<40	<190	<200	<33.0	2.3	<1.3	5.2	4.8
81. o-Cresol	<40	<190	<200	<33.0	<0.99	<1.3	<1.3	<2.2
82. p-Cresol	<40	<190	<200	<33.0	<0.99	<1.3	<1.3	<2.2
98. Di-n-butyl phthalate	<40	<190	<200	<33.0	<0.99	<1.3	<1.3	<2.2
121. Naphthalene	<40	<340	550	<33.0	3.0	1.8	15.0	14.0
141. Phenanthrene	<40	<190	540	95.0	4.7	1.8	25.0	24.0
142. Phenol	<40	<190	<200	<33.0	<0.99	<1.3	<1.3	<2.2
145. Pyrene	<40	<190	<200	43.0	3.3	1.8	14.0	13.0

Source: Exxon comments on EPA's Third Third proposed rule (Reference 55).

Table 3-4

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K049, K051, AND K048-K052 MIXTURE AT PLANT T - SOLVENT EXTRACTION

Regulated BDAT List Constituents	UNTREATED WASTE			TREATED WASTE		
	Concentration in K049 (mg/kg) Sample Set #1	Concentration in K051 (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture (mg/kg) Sample Sets 4-12	Concentration in K049 Raffinate Solids (mg/kg) Sample Set #1	Concentration in K051 Raffinate Solids (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture Raffinate Solids (mg/kg) Sample Sets 4-12
Volatile Organics						
4. Benzene	5.6	370.0	--	0.29	0.05	--
		133.7	--		0.09	--
			--			--
			--			--
			12.0			<0.1
			5.1			0.06
			9.6			<0.1
			13.7			<2.0
			5.1			<0.1
226. Ethylbenzene	--	<0.3	0.5	--	0.06	<0.1
		--	--		--	--
			0.6			<0.01
			--			--
			21.0			<0.1
			67.0			13.0
			13.0			<0.1
			20.2			<0.1
			13.0			<0.1
43. Toluene	28.9	390.0	0.7	1.46	<0.05	0.1
		59.4	--		0.04	--
			--			--
			--			--
			11.0			<0.1
			52.0			0.44
			16.0			<0.1
			54.4			<0.1
			52.0			<0.1

Source: Data submitted to USEPA by CF Systems (Reference 56).
-- Data not available.

Table 3-4 (Continued)

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K049, K051, AND K048-K052 MIXTURE AT PLANT T - SOLVENT EXTRACTION

Regulated BDAT List Constituents	UNTREATED WASTE			TREATED WASTE		
	Concentration in K049 (mg/kg) Sample Set #1	Concentration in K051 (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture (mg/kg) Sample Sets 4-12	Concentration in K049 Raffinate Solids (mg/kg) Sample Set #1	Concentration in K051 Raffinate Solids (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture Raffinate Solids (mg/kg) Sample Sets 4-12
Volatile Organics (continued)						
215 - 217. Xylenes (total)	55.2	1160.0	3.9	3.36	0.24	0.1
		1066.0	--		0.34	--
			6.9			0.13
			0.9			0.1
			78.0			<0.1
			71.0			0.59
			63.0			<0.1
			75.9			<0.1
			71.0			<0.1
Semivolatile Organics *						
57. Anthracene	--	667.0	86.0	--	10.0	18.0
		--	144.0		--	14.0
			351.0			10.2
			254.0			13.0
			143.0			13.0
			--			--
			--			--
			--			--
			--			--
70. Bis(2-ethylhexyl)phthalate	<5.4	--	--	0.25	--	--
		17.8	--		1.12	--
			--			--
			--			--
			--			--
			--			--
			--			--
			--			--
			--			--

Source: Data submitted to USEPA by CF Systems (Reference 56).
* Data are not available for benz(a)anthracene, benzo(a)pyrene, o-cresol, p-cresol, and phenol.
-- Data not available.

Table 3-4 (Continued)

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K049, K051, AND K048-K052 MIXTURE AT PLANT T - SOLVENT EXTRACTION

Regulated BDAT List Constituents	UNTREATED WASTE			TREATED WASTE		
	Concentration in K049 (mg/kg) Sample Set #1	Concentration in K051 (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture (mg/kg) Sample Sets 4-12	Concentration in K049 Raffinate Solids (mg/kg) Sample Set #1	Concentration in K051 Raffinate Solids (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture Raffinate Solids (mg/kg) Sample Sets 4-12
Semivolatile Organics * (continued)						
80. Chrysene	--	-- 17.7	-- -- -- -- -- -- -- -- --	--	-- 0.28	-- -- -- -- -- -- -- -- --
98. Di-n-butyl phthalate	<5.4	-- --	-- -- -- -- -- -- -- -- -- --	0.25	-- --	-- -- -- -- -- -- -- -- -- --
121. Naphthalene	15.8	-- 431.0	-- -- -- -- -- 50.0 -- -- 18.6	0.3	-- <0.28	-- -- -- -- -- 0.1 -- -- 0.2

Source: Data submitted to USEPA by CF Systems (Reference 56).
* Data are not available for benz(a)anthracene, benzo(a)pyrene, o-cresol, p-cresol, and phenol.
-- Data not available.

Table 3-4 (Continued)

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K049, K051, AND K048-K052 MIXTURE AT PLANT T - SOLVENT EXTRACTION

Regulated BDAT List Constituents	UNTREATED WASTE			TREATED WASTE		
	Concentration in K049 (mg/kg) Sample Set #1	Concentration in K051 (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture (mg/kg) Sample Sets 4-12	Concentration in K049 Raffinate Solids (mg/kg) Sample Set #1	Concentration in K051 Raffinate Solids (mg/kg) Sample Sets 2&3	Concentration in K048-K052 Mixture Raffinate Solids (mg/kg) Sample Sets 4-12
Semivolatile Organics * (continued)						
141. Phenanthrene	9.8	1360.0	94.0	0.38	12.0	9.6
		205.0	--		0.26	--
			52.0			2.6
			--			--
			56.0			<1.0
			20.0			0.16
			--			--
			--			--
			18.6			<0.2
145. Pyrene	4.5	<35.0	<35.0	0.33	3.0	5.4
		30.4	--		0.19	--
			<350.0			3.7
			38.0			2.7
			--			--
			--			--
			--			--
			--			--
			--			--

Source: Data submitted to USEPA by CF Systems (Reference 56).
* Data are not available for benz(a)anthracene, benzo(a)pyrene, o-cresol, p-cresol, and phenol.
-- Data not available.

Table 3-5

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K049 AND K051 MIXTURE AT PLANT R - STABILIZATION OF SOLVENT EXTRACTION RAFFINATE

BDAT List Constituents**	Sample Set	UNTREATED WASTE: Concentration in K049 and K051 (TCLP, mg/l)	TREATED WASTE *: Concentration in K049 and K051 (TCLP, mg/l)
Metals			
155. Arsenic	1	0.11	<0.003#
	2	0.007	<0.006#
159. Chromium (total)	1	0.11	<0.10#
	2	0.44	<0.05#
163. Nickel	1	0.15	0.13
	2	0.17	0.10

Source: Exxon comments on EPA's Third Third proposed rule (Reference 55).

* Unknown mixture of commercially available binders.
** Data were not available for selenium.
# ND or detected below detection limit. (Unknown whether or not the value reported is the detection limit.)

Table 3-6

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K048 AND K051 MIXTURE AT PLANT U - STABILIZATION OF FLUIDIZED BED INCINERATOR ASH

		Lime/Fly Ash Binder		Lime/Fly Ash/C/F Binder	
		UNTREATED WASTE	TREATED WASTE	UNTREATED WASTE	TREATED WASTE
BDAT List Constituents*	Sample Set	Concentration in K048 and K051 (TCLP, mg/l)	Concentration in K048 and K051 (TCLP, mg/l)	Concentration in K048 and K051 (TCLP, mg/l)	Concentration in K048 and K051 (TCLP, mg/l)
Metals					
155. Arsenic	1	0.171	0.008	0.171	0.021
	2		0.008		0.015
	3		0.008		0.092
	4		0.010		0.080
	5		0.011		
	6		<0.008		
	7		0.009		
	8		0.013		
	9		--		
159. Chromium (total)	1	1.13	0.47	1.13	1.01
	2		0.99		0.054
	3		0.61		0.61
	4		1.11		1.10
	5		1.04		
	6		0.98		
	7		1.03		
	8		0.71		
	9		0.86		
163. Nickel	1	0.324	0.061	0.324	0.113
	2		0.097		0.108
	3		0.097		0.314
	4		0.101		0.097
	5		0.099		
	6		0.104		
	7		0.108		
	8		0.129		
	9		0.138		

Source: Amoco comments on EPA's proposed Third Third rule (Reference 52).

-- Data for this constituent were either not reported or were rejected.
* Data were not available for selenium.

Table 3-7

PERFORMANCE DATA SUBMITTED BY INDUSTRY FOR TREATMENT OF K048 - K052 MIXTURE AT PLANT X - STABILIZATION OF SOLVENT EXTRACTION RAFFINATE

BDAT List Constituents**	Sample Set	UNTREATED WASTE: Concentration in K048-K052 Mixture (TCLP, mg/l)	TREATED WASTE *: Concentration in K048-K052 Mixture (TCLP, mg/l)
Metals			
159. Chromium (total)	1	0.07	<0.05
	2	0.26	<0.05
	3	0.21	<0.05
	4	0.09	<0.05
163. Nickel	1	0.21	<0.04
	2	0.27	<0.04
	3	0.27	0.06
	4	0.24	0.07

Source: BP America comments on EPA's Third Third proposed rule (Reference 50).

* Unknown mixture of commercially available binders.

** Data were not available for arsenic or selenium.

Table 3-8

DESIGN AND OPERATING PARAMETERS FOR STABILIZATION OF SOLVENT EXTRACTION RAFFINATE AT PLANT X

Physical Design Parameters	Values or Description
Binder	Commercial lime/flyash mixture, Portland cement, and iron salt
Cycle Time	Approximately 0.5 hours

Source: BP America's Comments on EPA's Proposed Third Third Rule (Reference 50).

Table 3-9

PERFORMANCE DATA COLLECTED BY EPA FOR TREATMENT OF K048
AT PLANT A - FLUIDIZED BED INCINERATOR COMBUSTION GAS SCRUBBER WATER

BDAT List Constituent	Sample Set	UNTREATED WASTE		TREATED WASTE	
		Detection Limit (mg/kg)	Concentration in K048 (mg/kg)	Detection Limit (mg/l)	Concentration in Combustion Gas Scrubber Water (mg/l)
169. Cyanide	1	0.6	<0.06	0.01	<0.01
	2	0.6	7.9	0.01	<0.01
	3	0.6	2.6	0.01	<0.01
	4	0.6	1.1	0.01	<0.01
	5	0.6	<0.06	0.01	<0.01
	6	0.6	4.5	0.01	<0.01

Source: Amoco Oil Company Onsite Engineering Report (Reference 6).

Table 3-10

DESIGN AND OPERATING PARAMETERS FOR THE
FLUIDIZED-BED INCINERATOR AT PLANT A

Physical Design Parameters	Value or Description
Incinerator manufacturer	Dorr-Oliver (Fluosolids)[R]
Incinerator height	40 ft.
Incinerator diameter:	
Base of incinerator	22 ft. (OD), 20 ft. (ID)
Top of incinerator	30 ft. (OD), 28 ft. (ID)
Wall thickness	1 ft. of refractory
Materials of construction:	
Reactor	Carbon steel wall with 12-inch refractory lining
Refractory	Refractory materials are cast blocks and laid bricks anchored with 304 stainless steel
Constriction	Refractory
Ducts	Refractory-lined carbon steel
Cyclones	Refractory-lined carbon steel
Venturi scrubber	304 ELC stainless steel
Stack	304 ELC stainless steel
Thickener tank	A36 steel
Bed material	Quartz white silica sand (#16 or #10 filter sand)
Stack diameter	5 ft.
Stack height	80 ft. (approximately)
Thickener tank capacity	80,070 gallons
Thickener tank dimensions:	
Diameter	40 ft.
Centerwell height	Approximately 8 feet and 6 inches

Source: Amoco Oil Company Onsite Engineering Report (Reference 6).

Table 3-10 (Continued)

DESIGN AND OPERATING PARAMETERS FOR THE
FLUIDIZED-BED INCINERATOR AT PLANT A

Physical Design Parameters	Value or Description[1]
Bed Temperature	1200-1300°F (1400°F Max.)
Freeboard Temperature	1250-1350°F (1450°F Max.)
Undewatered DAF Float Mixture Feed Rate	30-90 gpm
Constriction Plate Pressure Differential	15-20 in. H_2O
Fluidized-bed Pressure Differential	60-100 in. H_2O
Stack Gas Carbon Monoxide Concentration	35-800 ppm CO

[1]Ranges shown are nominal operating ranges as provided by plant personnel.

Source: Amoco Oil Company Onsite Engineering Report (Reference 6).

Table 3-11

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR ORGANICS IN K048-K052 NONWASTEWATERS

Data Rejected	Reasons for Rejection
Plants R and S:	
- Data from treatment by RCC's solvent extraction technology.	• Treatment not shown for bis(2-ethylhexyl) phthalate (possibly caused by lab contamination). • Bench-scale data rejected since pilot- and full-scale data are available.
- Data from treatment by BP America's solvent extraction technology.	• Treatment not shown for xylenes and naphthalene.
Plant T:	
- Texaco/Port Arthur - one sample set from treatment by CF Systems' solvent extraction technology.	• Treatment not shown for any constituents being regulated.
- Waterways Experiment Station - four sample sets from treatment by CF Systems' solvent extraction technology.	• QA/QC data not provided. • Improper sampling techniques.

Table 3-11 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR ORGANICS IN K048-K052 NONWASTEWATERS

Data Rejected	Reasons for Rejection
Plant U:	
- Amoco - one composite sample from treatment by CF Systems' solvent extraction technology.	• Detection limit not low enough in the untreated waste to show substantial treatment for 5 regulated constituents. • The data represent a composite of the 4 individual sample sets collected by EPA during the Agency-sponsored solvent extraction test using CF Systems' unit and, therefore, are not considered new data but rather a permutation of EPA's data.
Plant V:	
- Data from TDI's high temperature thermal distillation technology.	• Treatment not shown for most of the organic constituents being regulated. • QA/QC data not provided. • Waste codes unknown in some cases. • Analytical methods not reported.

Table 3-11 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR ORGANICS IN K048-K052 NONWASTEWATERS

Data Rejected	Reasons for Rejection
Plant W:	
- Data from treatment by CF Systems' solvent extraction technology.	• Most constituents not detected at or above detection limits in both the untreated and treated waste. • Treatment not shown for most of the organic constituents being regulated. • QA/QC data not provided.
- Two sets of data from treatment of K051 and one set from treatment of K048 and K051 filter cake.	
- One set of data from treatment of K051.	• Treatment not shown for most of the organic constituents being regulated. • QA/QC data not provided.
- Data from treatment by RCC's solvent extraction technology.	• Bench-scale data rejected since pilot- and full-scale data are available.
Plant X:	
- Data from treatment by BP America's solvent extraction technology.	• Treatment not shown for xylenes and naphthalene.

Table 3-11 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR ORGANICS IN K048-K052 NONWASTEWATERS

Data Rejected	Reasons for Rejection
Plant Y:	
- Data from treatment by RCC's solvent extraction technology.	• No untreated waste data provided. • Bench-scale data rejected since pilot- and full-scale data are available. • Data not provided for the volatile organic constituents being regulated.

Table 3-12

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR METALS IN K048-K052 NONWASTEWATERS

Regulated Metal Constituent	Data Rejected	Reasons for Rejection
Arsenic	Plant R:	
	- 3 sample sets of data from stabilization of solvent extraction residuals.	• Data not reported for other constituents being regulated in the sample set.
	Plant S:	
	- 4 sample sets of data from stabilization of incinerator ash.	• Do not show substantial treatment.
	Plant U:	
	- 11 sample sets of data from stabilization of incinerator ash.	• Data not reported for the untreated and/or treated waste. • Do not show substantial treatment. • Data do not show substantial treatment for other constituents being regulated in the sample set.

Table 3-12 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR METALS IN K048-K052 NONWASTEWATERS

Regulated Metal Constituent	Data Rejected	Reasons for Rejection
Arsenic (Continued)	Plant U: (Continued)	
	- 7 sample sets of data from stabilization of scrubber water solids.	• Do not show substantial treatment. • Data not reported for the untreated waste. • Data do not show substantial treatment for other constituents being regulated in the sample set.
	Plant X:	
	- 4 sample sets of data from stabilization of solvent extraction residual.	• Do not show substantial treatment.
Chromium	Plant R:	
	- 3 sample sets of data from stabilization of solvent extraction residual.	• Data not reported for the treated waste.

Table 3-12 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR METALS IN K048-K052 NONWASTEWATERS

Regulated Metal Constituent	Data Rejected	Reasons for Rejection
Chromium (Continued)	Plant S:	
	- 4 sample sets of data from stabilization of incinerator ash.	• Do not show substantial treatment. • Data do not show substantial treatment for other regulated constituents in the sample set.
	Plant U:	
	- 10 sample sets of data from stabilization of incinerator ash.	• Do not show substantial treatment. • Data not reported for the untreated waste.
	- 7 sample sets of data from stabilization of scrubber water solids	• Do not show substantial treatment. • Data not reported for the untreated waste.
Nickel	Plant R:	
	- 3 sample sets of data from stabilization of solvent extraction residual.	• Data not reported for the treated waste. • Data not reported for other constituents being regulated in the sample sets.

Table 3-12 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR METALS IN K048-K052 NONWASTEWATERS

Regulated Metal Constituent	Data Rejected	Reasons for Rejection
Nickel (Continued)	Plant S:	
	- 4 sample sets of data from stabilization of incineration ash.	• Data do not show substantial treatment.
	Plant U:	
	- 10 sample sets of data from stabilization of incinerator ash.	• Data not reported for the untreated and/or treated waste. • Data do not show substantial treatment for other constituents being regulated in the sample set.
	- 7 sample sets of data from stabilization of scrubber water solids.	• Data do not show substantial treatment. • Data not reported for the untreated waste. • Data do not show substantial treatment for other constituents being regulated in the sample set.

Table 3-12 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR METALS IN K048-K052 NONWASTEWATERS

Regulated Metal Constituent	Data Rejected	Reasons for Rejection
Selenium	Plant R:	
	- 5 sample sets of data from stabilization of solvent extraction residual.	• Data not reported for the untreated and/or treated waste.
	Plant S:	
	- 4 sample sets of data from stabilization of incinerator ash.	• Do not show substantial treatment.
	Plant U:	
	- 23 sample sets of data from stabilization of incinerator ash.	• Data do not show substantial treatment. • Data not reported for the untreated and/or treated waste. • Data do not show substantial treatment for other constituents being regulated in the sample set.
	- 7 sample sets of data from stabilization of scrubber water solids.	• Do not show substantial treatment. • Data not reported for the untreated waste. • Data do not show substantial treatment for other constituents being regulated in the sample set.

Table 3-12 (Continued)

DATA REJECTED FROM FURTHER CONSIDERATION FOR BDAT REVISIONS
TO TREATMENT STANDARDS FOR METALS IN K048-K052 NONWASTEWATERS

Regulated Metal Constituent	Data Rejected	Reasons for Rejection
Selenium (Continued)	Plant X:	
	- 4 sample sets of data from stabilization of solvent extraction residual.	• Do not show substantial treatment.

4.0 AMENDMENT TO SECTION 5.0 (IDENTIFICATION OF BEST DEMONSTRATED AND AVAILABLE TECHNOLOGY) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR K048-K052

This section amends Section 5.0 of the Final BDAT Background Document for K048-K052 as delineated below:

Section	Amended Section	Amendment Contents
4.1	5.1	Preliminary data review of the solvent extraction, stabilization, and incineration data presented in Section 3.0 of this document and considered for BDAT treatment standard revisions.
4.2	5.2.1	Accuracy correction of the solvent extraction data and stabilization data presented in Section 3.0 of this document and considered for BDAT treatment standard revisions.
4.3	5.2.2	Accuracy correction of the incineration data presented in Section 3.0 of this document.
4.4	5.3	Identification of BDAT for organic constituents in nonwastewaters (Comparison of solvent extraction treatment performance at Plants Q, R, and T.)
4.5	5.5	Identification of BDAT for metal constituents in nonwastewaters (Comparison of stabilization treatment performance at Plants R, U, X, and I.)
4.6	5.7	Identification of BDAT for cyanide in wastewaters.

4.1 Amendment to Section 5.1 - Preliminary Data Review

The additional treatment performance data that were considered by the Agency for BDAT treatment standard revisions are presented in Section 3.0. These data are from:

- Fluidized-bed incineration of K048 at Plant A
- Solvent extraction of K048 and K051 at Plant Q;
- Solvent extraction of K048, K049, K051, and K052 at Plant R;

- Solvent extraction of K049, K051, and a mixture of K048-K052 at Plant T;
- Stabilization of residual from solvent extraction treatment of K049 and K051 at Plant R;
- Stabilization of ash from incineration of K048 and K051 at Plant U; and
- Stabilization of the residual from solvent extraction treatment of a mixture of K048-K052 at Plant X.

These additional treatment performance data were reviewed and assessed to determine whether they represent operation of well-designed and well-operated treatment systems and whether sufficient quality assurance/quality control (QA/QC) measures were employed to ensure the accuracy of the data. Following the data review, the Agency had no reason to believe that any of these treatment systems were not well-designed or well-operated or that there were any insufficiencies in the QA/QC measures that were employed to ensure the accuracy of the data.

4.2 Amendment to Section 5.2.1 - Accuracy Correction of Treatment Performance Data for Nonwastewaters

4.2.1 Organics

Presented below is a description of how treatment performance data for solvent extraction treatment at Plant Q of organic constituents in nonwastewaters were adjusted for each regulated BDAT List constituent that was detected in the untreated waste. See Appendix D for detection limits of organic constituents in the untreated and treated wastes at Plant Q.

Matrix spike and duplicate matrix spike recoveries presented in Table B-5 of Appendix B of this document were used to adjust the treatment performance data for the residual solids from solvent extraction treatment of K048 and K051 from Plant Q. The matrix spike recovery used to adjust treatment performance data for each constituent was the lower of the two values from the matrix spike and the duplicate spike. For constituents for

which no matrix spike was performed, the average of the recoveries from the first spike and the average of the recoveries from the duplicate spike were calculated for the appropriate organic analytical fraction (volatile or semivolatile). The lower of the two averages was used to adjust the treatment performance data.

Accuracy correction factors presented in Table B-11 of Appendix B of this document were calculated for the residual solids data from Plant Q. (The accuracy correction factor is equal to 100 divided by the percent recovery.) Treatment performance data for each BDAT List organic constituent being regulated that was detected in the untreated waste were corrected for accuracy and are presented in Table 4-1. Matrix spike recoveries or average matrix spike recoveries greater than 100% (i.e., recoveries that would result in an accuracy correction factor less than 1.0) were considered to be 100% for the purpose of this calculation so that the data were not adjusted to concentrations below the detection limits. Matrix spike recoveries of less than 20% are not acceptable and were not used to correct detection.

Treatment performance data for incineration at Plant A of organic constituents in nonwastewaters were corrected for accuracy as discussed in Section 5.2.1 of the Final BDAT Background Document for K048-K052. Matrix spike recovery data were not submitted or were not available for nonwastewater organic constituents for the data sets from Plants R and T. However, in these cases, the Agency believes that sufficient quality assurance and quality control were employed in analysis of the data. Therefore, the data for Plants R and T were not adjusted for accuracy.

4.2.2 Metals

Matrix spike recovery data were not submitted or were not available for nonwastewater metal constituents for the data sets from Plants R, U, and X. However, in these cases, the Agency believes that sufficient quality assurance and quality control were employed in analysis of the data. Therefore, the data for Plants R, U, and X were not adjusted for accuracy.

4.3 Amendment to Section 5.2.2 - Accuracy Correction of Treatment Performance Data for Wastewaters

Presented below is a description of how treatment performance data for cyanide in scrubber water were adjusted for accuracy.

The matrix spike recovery and duplicate matrix spike recovery for cyanide in combustion gas scrubber water at Plant A were 102% and 104%, respectively. Since both recovery values are greater than 100%, and, if used, would result in an accuracy correction factor of less than 1.0, as previously explained in 4.2.1, an accuracy correction factor of 1.0 was used for cyanide. The corrected treatment concentrations for cyanide in the combustion gas scrubber water from fluidized-bed incineration are presented in Table 4-2.

4.4 Amendment to Section 5.3 - Identification of BDAT for Organic Constituents in K048-K052 Nonwastewaters

The Agency examined the performance of:

- Solvent extraction at Plant Q (CF Systems' five-pass solvent extraction unit);
- Solvent extraction at Plant R (CF Systems' three-pass solvent extraction unit);
- Solvent extraction at Plant T (CF Systems' three-pass solvent extraction unit); and
- Incineration at Plant A (Amoco's Whiting, IN fluidized-bed incinerator) discussed in the Final BDAT Background Document for K048-K052.

Although the solvent extraction data showed somewhat higher concentrations of organics in the treated waste than the incineration data, the organic constituent removal efficiency for solvent extraction data available to the Agency is 98%, on average, comparable to the 99.7% average efficiency achieved by incineration data available to the Agency. Additionally, solvent extraction provides the benefit of recovering as much as 365,000 barrels of oil per year (provided all of the K048-K052 generated per

year is treated using solvent extraction technologies rather than incineration).

As was determined in the Final BDAT Background Document for K048-K052, solvent extraction and incineration are BDAT for organic constituents in K048-K052 nonwastewaters. The Agency notes that in selecting both solvent extraction and incineration as BDAT for K048-K052, it has included a technology that does not destroy or remove the organic constituents of concern as well as incineration. EPA believes this is a permissible and rational choice to make given that solvent extraction is a recovery technology and the law voices a strong preference for use of such technologies. (See, e.g., H. R. Rep. No. 198, 98th Cong. 1st Sess. 31.) In addition, solvent extraction does perform substantial treatment on these wastes. Thus, the Agency believes its choice to be consistent with the language of RCRA Section 3004 (m) and also with the overall statutory goals of encouraging material reuse and waste minimization. (See, e.g. RCRA Section 1003 (6).)

4.5 Amendment to Section 5.5 - Identification of BDAT for Metal Constituents in K048-K052 Nonwastewaters

The Agency compared the performance of:

- Stabilization of fluidized-bed incinerator ash (ash generated from Amoco's Whiting, IN fluidized-bed incinerator) from Plant U (lime and fly ash binder and lime and fly ash C/F binder);
- Stabilization of fluidized-bed incinerator ash (ash generated from Amoco's fluidized-bed incinerator) from Plant I (lime and fly ash binder);
- Stabilization of solvent extraction residual (residual generated from BP America's multi-cycle solvent extraction unit) from Plant X (unknown mixture of commercially available binders); and
- Stabilization of solvent extraction residual (residual generated from BP America's multi-cycle solvent extraction unit) from Plant R (unknown mixture of commercially available binders).

A statistical comparison of this data showed that data sets for stabilization of solvent extraction residual submitted by Plants R and X showed overall better treatment for metal constituents than the data generated by EPA at Plant I or submitted by Plant U for stabilization of incinerator ash. Appendix C presents the statistical comparison of these data sets.

As was determined in the Final BDAT Background Document for K048-K052, stabilization is BDAT for metal constituents in K048-K052 nonwastewaters.

4.6 Amendment to Section 5.7 - Identification of BDAT for Cyanide in K048-K052 Wastewaters

Scrubber water is generated as a treatment residual from incineration in systems using wet scrubber air pollution control devices. The Agency has treatment performance data for cyanide in the combustion gas scrubber water residual from fluidized-bed incineration treatment of K048. As discussed in the Final BDAT Background Document for K048-K052, fluidized-bed incineration is demonstrated at full-scale for treatment of K048-K052. The Agency has no data from other technologies for treatment of cyanide in K048-K052 wastewaters. For this reason, EPA has determined that fluidized-bed incineration provides the "best" treatment for cyanide in K048 wastewaters. This technology is also "available" since it is commercially available and it provides substantial treatment of the cyanide in wastewaters as shown by the data in Table 3-9. The BDAT treatment standard for cyanide in K048 wastewaters is therefore based on the performance achieved in the combustion gas scrubber water from fluidized-bed incineration.

As discussed in Section 3.3 of this document, the Agency also has performance data for treatment of cyanide in wastewaters other than K048-K052 wastewaters by cyanide oxidation. However, the Agency prefers to use data from treatment of K048 to develop the treatment standard for cyanide in K048-K052 wastewaters because the cyanide oxidation data were not from treatment of K048-K052.

As discussed in Section 2.0 of the Final BDAT Background Document for K048-K052, EPA has determined that refinery wastes K048-K052 represent a single waste treatability group. Therefore, since fluidized-bed incineration is the technology basis for the BDAT treatment standard for cyanide in wastewater forms of K048, this technology also provides the basis for the BDAT treatment standard for cyanide in wastewater forms of K049, K050, K051, and K052.

Table 4-1

CORRECTED CONCENTRATION DATA FOR ORGANIC CONSTITUENTS
IN K048 AND K051 RESIDUAL SOLIDS FROM PLANT Q

Regulated BDAT List Constituents	Corrected Concentration in the Residual Solids			
	Sample Set #1 (mg/kg)	Sample Set #2 (mg/kg)	Sample Set #3 (mg/kg)	Sample Set #4 (mg/kg)
VOLATILE ORGANICS				
4. Benzene	0.41	0.16	0.24	0.18
226. Ethylbenzene	0.07	<0.06	<0.06	<0.06
43. Toluene	0.94	0.37	0.45	0.27
215-217. Xylenes (total)	0.26	0.13	0.12	0.12
SEMIVOLATILE ORGANICS				
57. Anthracene	<0.49	<0.49	<0.49	<0.49
59. Benz(a)anthracene	<0.49	<0.49	<0.49	<0.49
62. Benzo(a)pyrene	<0.49	<0.49	<0.49	<0.49
80. Chrysene	0.63	<0.49	<0.49	<0.49
82. p-Cresol	3.56	2.6	3.15	1.51
141. Phenanthrene	0.69	0.6	<0.49	0.54
142. Phenol	1.75	1.9	2.86	1.17
145. Pyrene	0.77	<0.38	<0.38	0.55

Table 4-2

CORRECTED CONCENTRATION DATA FOR CYANIDE IN K048
INCINERATION COMBUSTION GAS SCRUBBER WATER FROM PLANT A

Regulated BDAT List Constituent	Corrected Concentration in the Combustion Gas Scrubber Water (mg/l)					
	Sample Set #1	Sample Set #2	Sample Set #3	Sample Set #4	Sample Set #5	Sample Set #6
Inorganic						
169. Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

5.0 AMENDMENT TO SECTION 6.2 (SELECTION OF REGULATED CONSTITUENTS) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR K048-K052

5.1 Amendment to Section 6.2.1 - Selection of Regulated Metal Constituents in Nonwastewaters

This section amends Section 6.2.1 of the Final BDAT Background Document for K048-K052 to delete arsenic and selenium as regulated constituents in nonwastewater forms of K048-K052. Regulated constituents are selected based on several criteria, one of these being that data show substantial treatment for the constituent. Further analysis of the data from Plant I (the EPA-generated data) that were used to develop the First Third treatment standards for arsenic and selenium in K048-K052 show only marginal evidence of stabilization treatment for arsenic and selenium. As discussed in the proposed Third Third rule (54 FR 48431), the Agency believes that oxidation of these metals may be required prior to stabilization to achieve effective treatment. Additionally, none of the stabilization data submitted by industry show substantial treatment for arsenic or selenium. Therefore, the Agency is deleting the treatment standards for arsenic and selenium in nonwastewater forms of K048-K052.

5.2 Amendment to Section 6.2.2 - Selection of Regulated Constituents in Wastewaters

This section amends Sections 6.2.2 of the Final BDAT Background Document for K048-K052 to include cyanide as a regulated constituent in wastewater forms of K048-K052. Available characterization data for cyanide in untreated K048-K052 are summarized in Tables 2-4 through 2-8 of the Final BDAT Background Document for K048-K052. These data indicate that cyanide is present at treatable concentrations in all five refinery waste streams (K048, K049, K050, K051, and K052). Cyanide was not considered for regulation in K048-K052 wastewaters in the First Third rule because BDAT treatment performance data were not available soon enough to allow the Agency to fully evaluate the data. The Agency has completed its analysis of the treatment performance data for cyanide presented in Table 3-9 of this document and has

determined that the data show substantial treatment of cyanide. Therefore, cyanide is being selected for regulation in wastewater forms of K048, K049, K050, K051, and K052.

6.0 AMENDMENT TO SECTION 7.0 (CALCULATION OF TREATMENT STANDARDS) OF THE FINAL BDAT BACKGROUND DOCUMENT FOR K048-K052

This section amends Sections 7.1 and 7.2 of the Final BDAT Background Document for K048-K052 by presenting a discussion of the calculation of revised treatment standards for organic constituents and nickel in K048-K052 nonwastewaters and treatment standards for cyanide in K048-K052 wastewaters.

6.1 Amendment to Section 7.1 - Calculation of Treatment Standards for Organic Constituents in Nonwastewater Forms of K048-K052

The best measure of performance for waste recovery or destruction technologies, such as solvent extraction and incineration, is the total amount of constituent remaining in the treatment residual after treatment. Therefore, BDAT treatment standards for nonwastewater organic constituents were calculated based on total constituent concentration data. BDAT for organic constituents in nonwastewater forms of K048-K052 is solvent extraction and incineration. The treatment standards being promulgated for organic constituents in K048-K052 nonwastewaters were developed using the four sources of treatment performance data that were described in Section 3.0 of this document. The four data sources include:

- Four sample sets of treatment performance data for CF Systems' five-pass solvent extraction followed by centrifugation of K048 and K051 (from Plant Q);
- Four sample sets of treatment performance data for CF Systems' three-pass solvent extraction consisting of one sample set each of data for K048, K049, K051, and K052 (from Plant R);
- Twelve sample sets of treatment performance data for CF Systems' three-pass solvent extraction consisting of ten sample sets of data for a K048-K052 mixture, two sample sets of data for K051, and one sample set of data for K049 (from Plant T); and
- Six sample sets of treatment performance data for fluidized-bed incineration of K048 and K051 (from Plant A).

Table 4-1 of this document presents the accuracy-corrected total concentration values for organic constituents in the residual solids from solvent extraction at Plant Q. The total concentration values for organic constituents in the raffinate for solvent extraction at Plants R and T are presented in Tables 3-3 and 3-4, respectively, of this document. Table 5-1 of the final BDAT Background Document for K048-K052 presents the accuracy-corrected total concentration values for incinerator ash at Plant A. (The data for Plants R and T were not corrected for accuracy as discussed in Section 4.2.1.) Values are presented for all regulated organic constituents detected in the untreated or treated waste.

Tables 6-1 through 6-5 at the end of this section summarize the calculation of treatment standards for organic constituents in K048, K049, K050, K051, and K052 nonwastewaters, respectively. The treatment standard for each regulated organic constituent in K048-K052 nonwastewaters was calculated as follows: 1) The four available data sources from Plants Q, R, T, and A were reviewed to determine the sample set with the most difficult to treat waste, typically the one with the highest concentration value (including detection limit values) for the constituent in the untreated waste. The Agency assumed that high detection limit values in the untreated waste for several data sets indicated high concentrations of a constituent if other data (untreated waste data or presence of the constituent in the treated waste) indicated that the constituent was indeed present in the untreated waste but was not detected because of matrix interferences. 2) The concentration of the constituent in the treated waste that corresponded to the untreated waste concentration representing the most difficult to treat waste was then multiplied by a variability factor of 2.8 to determine the treatment standard for the constituent. The variability factor of 2.8 is used by the Agency to account for variability when only one data point is used in a treatment standard calculation (Reference 41).

EPA adopted this methodology in order to adequately account for the variability in K048-K052 wastes generated from different refineries, as evidenced by the range of constituent concentration data for untreated K048-K052 available to the Agency, presented in Section 2.0 of this document and

Section 2.0 of the Final BDAT Background Document for K048-K052. In order to develop realistic and achievable BDAT treatment standards, the Agency must account for the most difficult to treat wastes, typically those containing the highest concentrations in the untreated waste of the constituents of concern. Further, the treatment performance data available to the Agency indicate that solvent extraction technologies are to some extent waste matrix dependent. Thus, variations in waste feed must be taken into account in assessing the performance of solvent extraction technologies.

In addition, the Agency did not believe it would be technically valid to develop a variability factor for each constituent by pooling all of the available treatment performance data for solvent extraction, because the data were obtained from several different types of solvent extraction technologies and each treatment test generating data was conducted under different conditions (e.g., CF Systems' solvent extraction treatment data for three-pass and five-pass operation). The result of pooling the data would have been an artifically high variability factor leading to unrealistically high BDAT treatment standards.

The Agency believes that this methodology accounts for between-refinery variability in K048-K052. The Agency also accounted for the variability inherent in performance of treatment systems as well as in the collection and analysis of treated waste samples by using a variability factor in the calculation of revised BDAT treatment standards. Data for solvent extraction and incineration from all four sources considered by the Agency for development of revised treatment standards show that these technologies can meet the standards as promulgated.

Treatment standards for four of the regulated constituents, benz(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, and chrysene, are based on treated waste data from Plant R that correspond to untreated waste data below the detection limit. Because these constituents were present in the treated waste, and based on the available characterization data, the Agency believes that these constituents were also present in the untreated waste from Plant R but were not detected because of matrix interferences.

Therefore, the data from Plant R were used to calculate treatment standards for these constituents.

Treatment standards for di-n-butyl phthalate, o-cresol, p-cresol, and phenol were based on detection limit data for the treated waste from Plant R that correspond to untreated waste data also below the detection limit. Based on the available characterization data (see Section 2.0), the Agency believes that these constituents were present in the untreated waste from Plant R but were not detected because of matrix interferences. Therefore, the data from Plant R were used to calculate treatment standards for these constituents.

The calculation of treatment standards for constituents for which the most difficult to treat waste did not correspond to the highest concentration of the constituent in the untreated waste is described below:

4. Benzene. The highest concentration value for benzene in the untreated waste, 370 ppm from Plant R, corresponds to a treated waste value of 0.05 ppm. The resulting treatment standard would be so low that it would preclude the use of many solvent extraction and incineration technologies for treatment of K048-K052. Therefore, the Agency used the benzene concentration in the treated waste of <5 ppm from Plant R, sample set 3, which contains the highest overall concentrations of volatile constituents in the untreated waste, to calculate the treatment standard for benzene.

81. and 82. o-Cresol and p-Cresol. These constituents are regulated only in K052 nonwastewaters. Therefore, the Agency considered treatment performance data for only K052 in calculating the treatment standards for o-cresol and p-cresol. The highest concentrations for o-cresol and p-cresol in untreated K052 are from Plant R. Neither constituent was present at or above detection in the untreated or treated K052 from any of the four data sources. However, based on the available characterization data for K052 (see Section 2.0), the Agency believes that o-cresol and p-cresol were present in the untreated K052 from Plant R but were not detected because of matrix interferences in the untreated waste. Therefore, the data from

treatment of K052 at Plant R were used to calculate the treatment standards for o-cresol and p-cresol.

98. Di-n-butyl phthalate. The highest concentration value for di-n-butyl phthalate in an individual untreated waste is 230 ppm from K051 treated at Plant A. However, the waste feed at Plant A was a mixture of 34% K048 and 66% K051. Considering the contribution of di-n-butyl phthalate from each waste, the highest concentration of di-n-butyl phthalate in the untreated waste mixture is 182 ppm. Therefore, the highest concentration for di-n-butyl phthalate in a single untreated waste from the four data sources considered is <200 ppm from Plant R. The corresponding treated waste value of <1.3 ppm was used to calculate the treatment standard for di-n-butyl phthalate. As discussed above for o-cresol and p-cresol, the Agency believes based on the available characterization data that di-n-butyl phthalate was present in the untreated waste at Plant R, but was not detected because of matrix interferences.

145. Pyrene. The highest concentration value for pyrene in an untreated waste, <350 ppm from Plant T, corresponds to a treated waste value of 3.7 ppm. The Agency believes that calculating a treatment standard based on this number would result in a treatment standard so low that it would preclude the use of some solvent extraction technologies for treatment of K048-K052. The untreated waste value of 43 ppm from Plant R, with a corresponding treated waste value of 13 ppm, was selected by the Agency as the sample set that accounts for waste variability while resulting in a treatment standard that is as low as possible and that can be met by all of the solvent extraction and incineration technologies considered in developing the revised BDAT treatment standards.

6.2 Amendment to Section 7.1 - Calculation of Treatment Standard for Nickel in Nonwastewater Forms of K048-K052

Stabilization reduces the leachability of metals in a waste. The best measure of performance for stabilization technologies is the analysis of an extract of the waste using the toxicity characteristic leaching procedure

(TCLP). Therefore, the BDAT treatment standard for nickel in nonwastewater forms of K048-K052 was calculated based on TCLP data.

BDAT for metal constituents in nonwastewater forms of K048-K052 is stabilization. Treatment performance achieved for each of the available data sets discussed in Section 3.0 of this document was statistically compared using Duncan's Multiple-Range Test. (Tables 3-5, 3-6, and 3-7 of this document present the TCLP values for nickel in the untreated and treated wastes from Plants R, U, and X, respectively. Table 4-17 of the Final BDAT Background Document for K048-K052 presents the TCLP values for nickel in the untreated and treated wastes from Plant I.) Results of the statistical comparison indicate that the data from Plants R and X demonstrated better treatment performance than the data from Plants I or U. Data from Plants R and X were generated using the same technology and were pooled to calculate the standard for nickel. (Results of the statistical comparison are presented in Appendix C of this document.) Therefore, the BDAT treatment standard for nickel in K048-K052 nonwastewaters was calculated based on six sample sets of treatment performance data for stabilization of solvent extraction residual: four sample sets from multicycle solvent extraction of a K048-K052 mixture at Plant X; and two sample sets of data from multicycle solvent extraction of K049 and K051 at Plant R.

The treatment standard for nickel was calculated by first averaging the six treated waste values. A variability factor was then calculated from the six treated waste values, and the variability factor was multiplied by the average of the treated waste values to determine the treatment standard. (A detailed discussion on the calculation of variability factors is presented in Reference 41.) Table 6-6 at the end of this section summarizes the calculation of the treatment standard for nickel in K048-K052 nonwastewaters.

6.3 Amendment to Section 7.2 - Calculation of Treatment Standard for Cyanide in Wastewater Forms of K048-K052

Incineration generally results in the generation of two treatment residuals: ash (a nonwastewater form) and combustion gas scrubber water (a wastewater form). The best measure of performance for a destruction technology, such as incineration, is the total amount of constituent remaining after treatment. Therefore, the BDAT treatment standard for cyanide in wastewaters was calculated based on total constituent concentration in the combustion gas scrubber water.

The BDAT treatment standard for cyanide in K048-K052 wastewaters was calculated based on six sample sets of treatment performance data for combustion gas scrubber water from fluidized-bed incineration of K048. These treatment performance data were then transferred to K049, K050, K051, and K052. Table 4-2 of this document presents the accuracy-corrected total concentration values for cyanide in the untreated and treated wastes for fluidized-bed incineration at Plant A.

The treatment standard for cyanide was calculated by first averaging the six accuracy-corrected treated waste values. A variability factor was then calculated from the six treated waste values, and the variability factor was multiplied by the average of the corrected treated waste values to determine the treatment standard. (A detailed discussion on the calculation of variability factors is presented in Reference 41.) Table 6-7 at the end of this section summarizes the calculation of the treatment standard for cyanide in K048-K052 wastewaters.

Table 6-1

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR ORGANIC CONSTITUENTS IN K048

Regulated BDAT List Constituents	Data Source +	Technology Basis *	Highest Concentration in Untreated Waste (mg/kg)	Corresponding Concentration in Treated Waste (mg/kg)	Variability Factor (VF)	Treatment Standard # (Treated Waste Conc. x VF) (mg/kg)
Volatiles						
4. Benzene	Plant R	CFS 3-Pass	100 **	<5.0	2.8	14
226. Ethylbenzene	Plant R	CFS 3-Pass	160	<5.0	2.8	14
43. Toluene	Plant R	CFS 3-Pass	1300	<5.0	2.8	14
215.-217. Xylenes (total)	Plant R	CFS 3-Pass	1600	7.9	2.8	22
Semivolatiles						
62. Benzo(a)pyrene	Plant R	CFS 3-Pass	<200	4.3	2.8	12.
70. Bis(2-ethylhexyl)phthalate	Plant R	CFS 3-Pass	<200	2.61	2.8	7.3
80. Chrysene	Plant R	CFS 3-Pass	<200	5.2	2.8	15.
98. Di-n-butyl phthalate	Plant R	CFS 3-Pass	<200 **	<1.3	2.8	3.6
121. Naphthalene	Plant R	CFS 3-Pass	550	15.0	2.8	42.
141. Phenanthrene	Plant T	CFS 3-Pass	1360	12.0	2.8	34.
142. Phenol	Plant R	CFS 3-Pass	<200	<1.3	2.8	3.6
145. Pyrene	Plant R	CFS 3-Pass	43 **	13.0	2.8	36.

+ See Appendix A of this document for plant codes.
* CF Systems' propane solvent extraction unit.
** This value does not correspond to the highest concentration in the untreated waste for this constituent. See Section 6-1 for a description of the treatment standard calculation for this constituent.
# These values have been rounded off to show two significant figures only.

Table 6-2

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR ORGANIC CONSTITUENTS IN K049

Regulated BDAT List Constituents	Data Source +	Technology Basis *	Highest Concentration in Untreated Waste (mg/kg)	Corresponding Concentration in Treated Waste (mg/kg)	Variability Factor (VF)	Treatment Standard # (Treated Waste Conc. x VF) (mg/kg)
Volatiles						
4. Benzene	Plant R	CFS 3-Pass	100 **	<5.0	2.8	14
226. Ethylbenzene	Plant R	CFS 3-Pass	160	<5.0	2.8	14
43. Toluene	Plant R	CFS 3-Pass	1300	<5.0	2.8	14
215.-217. Xylenes (total)	Plant R	CFS 3-Pass	1600	7.9	2.8	22
Semivolatiles						
57. Anthracene	Plant T	CFS 3-Pass	667	10.0	2.8	28
62. Benzo(a)pyrene	Plant R	CFS 3-Pass	<200	4.3	2.8	12
70. Bis(2-ethylhexyl)phthalate	Plant R	CFS 3-Pass	<200	2.61	2.8	7.3
80. Chrysene	Plant R	CFS 3-Pass	<200	5.2	2.8	15
121. Naphthalene	Plant R	CFS 3-Pass	550	15.0	2.8	42
141. Phenanthrene	Plant T	CFS 3-Pass	1360	12.0	2.8	34
142. Phenol	Plant R	CFS 3-Pass	<200	<1.3	2.8	3.6
145. Pyrene	Plant R	CFS 3-Pass	43 **	13.0	2.8	36

+ See Appendix A of this document for plant codes.
* CF Systems' propane solvent extraction unit.
** This value does not correspond to the highest concentration in the untreated waste for this constituent. See Section 6-1 for a description of the treatment standard calculation for this constituent.
# These values have been rounded off to show two significant figures only.

Table 6-3

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR ORGANIC CONSTITUENTS IN K050

Regulated BDAT List Constituents	Data Source +	Technology Basis *	Highest Concentration in Untreated Waste (mg/kg)	Corresponding Concentration in Treated Waste (mg/kg)	Variability Factor (VF)	Treatment Standard # (Treated Waste Conc. x VF) (mg/kg)
Volatiles						
62. Benzo(a)pyrene	Plant R	CFS 3-Pass	<200	4.3	2.8	12
142. Phenol	Plant R	CFS 3-Pass	<200	<1.3	2.8	3.6

+ See Appendix A of this document for plant codes.
* CF Systems' propane solvent extraction unit.
# These values have been rounded off to show two significant figures only.

Table 6-4

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR ORGANIC CONSTITUENTS IN K051

Regulated BDAT List Constituents	Data Source +	Technology Basis *	Highest Concentration in Untreated Waste (mg/kg)	Corresponding Concentration in Treated Waste (mg/kg)	Variability Factor (VF)	Treatment Standard # (Treated Waste Conc. x VF) (mg/kg)
Volatiles						
4. Benzene	Plant R	CFS 3-Pass	100 **	<5.0	2.8	14
226. Ethylbenzene	Plant R	CFS 3-Pass	160	<5.0	2.8	14
43. Toluene	Plant R	CFS 3-Pass	1300	<5.0	2.8	14
215.-217. Xylenes (total)	Plant R	CFS 3-Pass	1600	7.9	2.8	22
Semivolatiles						
57. Anthracene	Plant T	CFS 3-Pass	667	10.0	2.8	28
59. Benz(a)anthracene	Plant R	CFS 3-Pass	<200	7.2	2.8	20
62. Benzo(a)pyrene	Plant R	CFS 3-Pass	<200	4.3	2.8	12
70. Bis(2-ethylhexyl)phthalate	Plant R	CFS 3-Pass	<200	2.61	2.8	7.3
80. Chrysene	Plant R	CFS 3-Pass	<200	5.2	2.8	15
98. Di-n-butyl phthalate	Plant R	CFS 3-Pass	<200 **	<1.3	2.8	3.6
121. Naphthalene	Plant R	CFS 3-Pass	550	15.0	2.8	42
141. Phenanthrene	Plant T	CFS 3-Pass	1360	12.0	2.8	34
142. Phenol	Plant R	CFS 3-Pass	<200	<1.3	2.8	3.6
145. Pyrene	Plant R	CFS 3-Pass	43 **	13.0	2.8	36

+ See Appendix A of this document for plant codes.
* CF Systems' propane solvent extraction unit.
** This value does not correspond to the highest concentration in the untreated waste for this constituent. See Section 6-1 for a description of the treatment standard calculation for this constituent.
# These values have been rounded off to show two significant figures only.

Table 6-5

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR ORGANIC CONSTITUENTS IN K052

Regulated BDAT List Constituents	Data Source +	Technology Basis *	Highest Concentration in Untreated Waste (mg/kg)	Corresponding Concentration in Treated Waste (mg/kg)	Variability Factor (VF)	Treatment Standard # (Treated Waste Conc. x VF) (mg/kg)
Volatiles						
4. Benzene	Plant R	CFS 3-Pass	100 **	<5.0	2.8	14
226. Ethylbenzene	Plant R	CFS 3-Pass	160	<5.0	2.8	14
43. Toluene	Plant R	CFS 3-Pass	1300	<5.0	2.8	14
215.-217. Xylenes (total)	Plant R	CFS 3-Pass	1600	7.9	2.8	22
Semivolatiles						
62. Benzo(a)pyrene	Plant R	CFS 3-Pass	<200	4.3	2.8	12
81. o-Cresol	Plant R	CFS 3-Pass	<33 **	<2.2	2.8	6.2
82. p-Cresol	Plant R	CFS 3-Pass	<33 **	<2.2	2.8	6.2
121. Naphthalene	Plant R	CFS 3-Pass	550	15.0	2.8	42
141. Phenanthrene	Plant T	CFS 3-Pass	1360	12.0	2.8	34
142. Phenol	Plant R	CFS 3-Pass	<200	<1.3	2.8	3.6

+ See Appendix A of this document for plant codes.
* CF Systems' propane solvent extraction unit.
** This value does not correspond to the highest concentration in the untreated waste for this constituent. See Section 6-1 for a description of the treatment standard calculation for this constituent.
# These values have been rounded off to show two significant figures only.

Table 6-6

CALCULATION OF NONWASTEWATER TREATMENT STANDARDS FOR NICKEL IN K048-K052

Regulated Constituent	Concentration in Untreated Waste* (TCLP, mg/l)	Technology Basis	Arithmetic Average of Corrected Treatment Values (TCLP, mg/l)	Variability Factor (VF)	Treatment Standard # (Average x VF) (TCLP, mg/l)
Metal					
164. Nickel	0.15 - 0.27	Stabilization	0.0733	2.77	0.20

* This is the range of concentrations for nickel in the raffinate from solvent extraction treatment of K049 and K051 from Plant R, and a K048-K052 mixture from Plant X.
\# This value has been rounded off to show two significant figures only.

Table 6-7

CALCULATION OF WASTEWATER TREATMENT STANDARDS FOR CYANIDE IN K048-K052*

Regulated Constituent	Concentration in Untreated Waste ** (mg/l)	Technology Basis	Arithmetic Average of Corrected Treatment Values (mg/l)	Variability Factor (VF)	Treatment Standard # (Average X VF) (mg/l)
Inorganics					
169. Cyanide	<0.06 - 7.9	Incineration	0.01	2.8	0.028

* Treatment performance data for cyanide in K048 were transferred to K049, K050, K051, and K052.
** This is the range of concentrations for cyanide in the untreated K048 and K051 from fluidized bed incineration at Plant A.
# This value has been rounded off to show two significant figures only.

7.0 ACKNOWLEDGEMENTS

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The following personnel from Radian Corporation were involved in preparing this document: John Williams, Program Manager; Mary Willett, Project Director; and the Radian engineering team, Wendy Rovansek, and Tania Ashman-Allam.

The K048/K051 solvent extraction treatment test conducted by EPA was performed at the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi by CF Systems. CF Systems personnel who operated the solvent extraction unit during the treatment test were John Markiewicz and Steve LeBlanc. The fluidized-bed incineration treatment test conducted by EPA was performed at Amoco Oil Company in Whiting, Indiana. Field sampling for both treatment tests was conducted by Radian Corporation. Characterization sampling was performed at Amoco Oil Company by Radian Corporation. Amoco Oil Company provided the wastes used in both the fluidized-bed incineration and solvent extraction treatment tests conducted by the Agency.

The cooperation of the American Petroleum Institute (API) and the individual companies from which samples were collected (especially Amoco Oil Company) and that submitted detailed information and data to the U.S. EPA on K048-K052 is appreciated.

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APPENDIX A

AMENDMENT TO APPENDIX C - REVISED SUMMARY OF PETROLEUM REFINERY PLANT CODES

Table A-1

REVISED SUMMARY OF PETROLEUM REFINERY PLANT CODES

Plant Code	Plant Name and Location	Data Source
A	Amoco Oil Company, Whiting Refinery Whiting, Indiana	EPA-Sponsored Treatment Test (References 6 and 8)
B	Unknown	API Report (Reference 26)
C	Unknown	API Report (Reference 26)
D	Unknown	API Report (Reference 26)
E	Unknown	API Report (Reference 26)
F	Unknown	API Report (Reference 26)
G	General Refining Superfund Site Garden City, Georgia	Resources Conservation Company (Reference 37)
H	Unknown	API Report (Reference 26)
I	USAE Waterways Experiment Station Vicksburg, Mississippi	EPA-Sponsored Treatment Test (Reference 7)
J	Unknown	API Report (Reference 26)
K	SOHIO Oil, Alliance Refinery, (Pilot plant results), Belle Chasse, Louisiana	BP America (Reference 29)
L	Unknown	CF Systems (Reference 30)
M	SOHIO Oil Alliance Refinery (full-scale results), Belle Chasse, Louisiana	BP America (Reference 36)

Table A-1 (Continued)

REVISED SUMMARY OF PETROLEUM REFINERY PLANT CODES

Plant Code	Plant Name and Location	Data Source
N	Unknown	API Report (Reference 26)
O	Unknown	CF Systems (Reference 38)
P	Envirite Corporation York, Pennsylvania	EPA-Sponsored Treatment Test (Reference 27)
Q	Waterways Experiment Station Vicksburg, Mississippi	EPA-Sponsored Treatment Test (Reference 43)
R	Exxon Refineries (Data from treatment by CF Systems' pilot-scale, RCC's pilot-scale and bench-scale, and BP America's multicycle solvent extraction units) (Locations Unknown)	Exxon (Reference 55)
S	Unknown	American Petroleum Institute (Reference 45)
T	Petro Canada, D'Anjou, Texaco, Port Arthur, Texas, and Waterways Experiment Station, Vicksburg, Mississippi	CF Systems (Reference 56)
U	Amoco R&D Naperville, Illinois	Amoco Corporation (Reference 52)
V	Unknown	Thermal Dynamics Inc. (Reference 48)

Table A-1 (Continued)

REVISED SUMMARY OF PETROLEUM REFINERY PLANT CODES

Plant Code	Plant Name and Location	Data Source
W	Shell Oil Company (CF System's pilot-scale solvent extraction unit) Martinez, California and Resources Conservation Company Laboratories (RCC's bench-scale solvent extraction unit) (Location Unknown)	Shell Oil Company (Reference 49)
X	BP America Alliance Refinery Belle Chasse, Louisiana	BP America (Reference 50)
Y	Resources Conservation Company Laboratories (Location Unknown)	Resources Conservation Company (Reference 51)

Appendix B

ANALYTICAL QA/QC

ANALYTICAL QA/QC

This appendix identifies the analytical methods used for analysis of the BDAT List organic constituents in the nonwastewater residual from the solvent extraction test conducted at Plant Q by the Agency and of cyanide in the wastewater residual from the incineration test conducted at Plant A by the Agency. Table B-1 presents the methods used for the analysis of the volatile and semivolatile organic constituents and cyanide. Only SW-846 Methods (EPA's Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846) were used for determining total constituent concentrations.

In some instances, it was necessary to deviate from the SW-846 methods. These deviations are given below:

- Table B-2: specific procedures used in extraction of organic compounds when alternatives to SW-846 methods are allowed by approval of EPA's Characterization and Assessment division.
- Table B-3: specific procedures or equipment used in extraction of organic compounds when alternatives or equivalents are allowed in the SW-846 methods.
- Table B-4: specific procedures or equipment used for analysis of organic compounds and cyanide when alternatives or equivalents are allowed in SW-846 methods.

BDAT List organic constituent concentrations are corrected for accuracy based on matrix spike recoveries and matrix spike duplicate recoveries. These recoveries from Plants Q and A are given in Table B-5. Results for the laboratory duplicate injections from Plants Q and A are given in Table B-6.

Table B-7 gives calibration procedures specified in SW-846 used to analyze for BDAT List organic constituents and cyanide, and Table B-8 gives the sources and purities of calibration standards used. Table B-9 gives the sources and/or purities of system performance check compounds and calibration check standards used. Table B-10 gives the purities of solvents and acids used.

In order to account for inaccuracies due to matrix interferences in the data on the treated waste, accuracy correction factors for the BDAT list organic constituents and cyanide are presented in Table B-11.

TABLE B-1

ANALYTICAL METHODS

Analysis/Methods	Method
VOLATILE ORGANICS	
Purge-and-Trap	5030
Gas Chromatography/Mass Spectrometry for Volatile Organics	8240
SEMIVOLATILE ORGANICS	
Gel Permeation Chromatography (GPC)	3640
Sonication Extraction	3550
Gas Chromatography/Mass Spectroscopy for Semivolatile Organics: (Capillary Column Technique)	8270
Continuous Liquid-Liquid Extraction	3520
INORGANICS	
Cyanide	9010

REFERENCE: U.S. EPA, Test Methods for Evaluating Solid Waste, SW-846 Third Edition, Office of Solid Waste and Emergency Response, Washington, D.C., November 1986.

Table B-2

SPECIFIC PROCEDURES USED IN EXTRACTION OF ORGANIC COMPOUNDS WHEN ALTERNATIVES TO SW-846 METHODS ARE ALLOWED BY APPROVAL OF EPA CHARACTERIZATION AND ASSESSMENT DIVISION

Analysis	SW-846 method	Sample aliquot	SW-846 specification	Specific procedures allowed by approval of EPA-CAD
Continuous liquid-liquid extraction	3520	1 liter	• The internal standards are prepared by dissolution in carbon disulfide and then dilution to such volume that the final solvent is 20% carbon disulfide and 80% methylene chloride.	• The preparation of the internal standards is changed to eliminate the use of carbon disulfide. The internal standards are prepared in methylene chloride only.
Sonication extraction	3550	1 gram for high concentrations and 30 grams for low concentrations	• The internal standards are prepared by dissolution in carbon disulfide and then dilution to such volume that the final solvent is 20% carbon disulfide and 80% methylene chloride.	• The preparation of the internal standards is changed to eliminate the use of carbon disulfide. The internal standards are prepared in methylene chloride only.

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Table B-3

SPECIFIC PROCEDURES OR EQUIPMENT USED IN EXTRACTION OF ORGANIC COMPOUNDS WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Purge-and-trap	5030	5 milliliters of liquid; 1 gram of solid	• The purge-and-trap device to be used is specified in Figure 1 of the method. The desorber to be used is described in Figures 2 and 3, and the packing materials are described in Section 4.10.2 of SW-846. The method allows equivalents of this equipment or materials to be used.	• The purge-and-trap equipment and the desorber used are as specified in SW-846. The purge-and-trap equipment is a Teckmar LSC-2 with standard purging chambers (Supelco cat. 2-0293). The packing materials for the traps are 1/3 silica gel and 2/3 2,6-diphenylene.
			• The method specifies that the trap must be at least 25 cm long and have an inside diameter of at least 0.105 cm.	• The length of the trap is 30 cm and the diameter is 0.105 cm.
			• The surrogates recommended are toluene-d8,4-bromofluorobenzene, and 1,2-dichloroethane-d4. The recommended concentration level is 50 µg/l.	• The surrogates are added as specified in SW-846.
Sonication extraction	3550	1 gram of solid for high concentrations and 30 grams for low concentrations	• The recommended surrogates and their concentrations are the same as for Method 3520.	• The surrogates used and their concentration levels are the same as for Method 3520.
			• Sample grinding may be required for sample not passing through a 1-mm standard sieve or a 1-mm opening.	• Sample grinding is not required.

Table B-3 (Continued)

SPECIFIC PROCEDURES OR EQUIPMENT USED IN EXTRACTION OF ORGANIC COMPOUNDS WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample aliquot	Alternatives or equivalents allowed by SW-846 methods	Specific procedures or equipment used
Continuous liquid-liquid extraction	3520	1 liter of liquid	• Acid and base/neutral extracts are usually combined before analysis by GC/MS. Under some situations, however, they may be extracted and analyzed separately.	• Acid and base/neutral extracts are combined.
			• The base/neutral surrogates recommended are 2-fluorobiphenyl, nitrobenzene-d5, and terphenyl-d14. The acid surrogates recommended are 2-fluorophenol, 2,4,6-tribromophenol, and phenol-d6. Additional compounds may be used for surrogates. The recommended concentrations for low-medium concentration level samples are 100 ppm for acid surrogates and 200 ppm for base/neutral surrogates. Volume of surrogate may be adjusted.	• Surrogates are the same as those recommended by SW-846, with the exception that phenol-d5 is substituted for phenol-d6. The concentrations used are the concentrations recommended in SW-846.

Table B-4

SPECIFIC PROCEDURES OR EQUIPMENT USED IN ANALYSIS OF ORGANIC COMPOUNDS AND CYANIDE WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure	Specific equipment or procedures used
Gas chromatography/ mass spectrometry for volatile organics	8240	5030	**Recommended GC/MS operating conditions:**	**Actual GC/MS operating conditions:**
			Electron energy: 70 ev (nominal)	Electron energy: 70 ev
			Mass range: 35-260 amu	Mass range: 35-260 amu
			Scan time: To give 5 scans/peak but not to exceed 7 sec/scan	Scan time: 2.5 sec/scan
			Initial column temperature: 45°C	Initial column temperature: 38°C
			Initial column holding time: 3 min	Initial column holding time: 2 min
			Column temperature program: 8°C/min	Column temperature program: 10°C/min
			Final column temperature: 200°C	Final column temperature: 225°C
			Final column holding time: 15 min	Final column holding time: 30 min or xylene elutes
			Injector temperature: 200-225°C	Injector temperature: 225°C
			Source temperature: According to manufacturer's specification	Source temperature: Manufacturer's recommended value of 100°C
			Transfer line temperature: 250-300°C	Transfer line temperature: 275°C
			Carrier gas: Hydrogen at 50 cm/sec or helium at 30 cm/sec	Carrier gas: Helium at 30 ml/min
			The column should be 6 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh) or an equivalent.	The column used is an 8 ft x 0.1 in I.D. glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh).
			Samples may be analyzed by purge-and-trap technique or by direct injection.	The samples are analyzed using the purge-and-trap technique.
				Additional information on actual system used: Equipment: Finnegan model 5100 GC/MS/DS system Data system: SUPERINCOS Autoquan Mode: Electron impact NBS library available Interface to MS - Jet separator

Table B-4 (Continued)

SPECIFIC PROCEDURES OR EQUIPMENT USED IN ANALYSIS OF ORGANIC COMPOUNDS AND CYANIDE WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure		Specific equipment or procedures used	
			Recommended GC/MS operating conditions:		**Actual GC/MS operating conditions:**	
Gas chromatography/ mass spectrometry for semivolatile organics: capillary column technique	8270	3520-liquids 3550, 3640-solids	Mass range:	35-500 amu	Mass range:	35-500 amu
			Scan time:	1 sec/scan	Scan time:	1 sec/scan
			Initial column temperature:	40°C	Initial column temperature:	30°C
			Initial column holding time:	4 min	Initial column holding time:	4 min
			Column temperature program:	40-270°C at 10°C/min	Column temperature program:	8°C/min to 275° and 10°C/min until 305°C
			Final column temperature hold:	270°C (until benzo[g,h,i,]perylene has eluted)	Final column temperature hold:	305°C
			Injector temperature:	250-300°C	Injector temperature:	240-260°C
			Transfer line temperature:	250-300°C	Transfer line temperature:	300°C
			Source temperature:	According to manufacturer's specification	Source temperature:	Manufacturer's recommendation (nonheated)
			Injector:	Grob-type, splitless	Injector:	Grob-type, splitless
			Sample volume:	1-2 µl	Sample volume:	1 µl of sample extract
			Carrier gas:	Hydrogen at 50 cm/sec or helium at 30 cm/sec	Carrier gas:	Helium at 40 cm/sec
			The column should be 30 m by 0.25 mm I.D., 1-µm film thickness silicon-coated fused silica capillary column (J&W Scientific DB-5 or equivalent).		The column used is a 30 m x 0.32 mm I.D. RT_X -5 (5% phenyl methyl silicone) FSCC.	
					Additional information on actual system used: Equipment: Finnegan model 5100 GC/MS/DS system Software Package: SUPERINCOS Autoquan	

Table B-4 (Continued)

SPECIFIC PROCEDURES OR EQUIPMENT USED IN ANALYSIS OF ORGANIC COMPOUNDS AND CYANIDE WHEN ALTERNATIVES OR EQUIVALENTS ARE ALLOWED IN THE SW-846 METHODS

Analysis	SW-846 method	Sample preparation method	Alternatives or equivalents allowed in SW-846 for equipment or in procedure	Specific equipment or procedures used
Gel permeation clean-up	3640		The column can be calibrated either manually or automatically.	The column is calibrated automatically using a UV detector with a flow through cell.
Total and Amenable Cyanide	9010		Hydrogen sulfide treatment may be required. A Fisher-Hulligan absorber or equivalent should be used.	Hydrogen sulfide treatment was required. A Fisher-Hulligan absorber was used.

Table B-5

MATRIX SPIKE RECOVERIES USED TO CORRECT TREATMENT PERFORMANCE DATA FOR ORGANICS IN NONWASTEWATERS FROM SOLVENT EXTRACTION AT PLANT Q AND FOR CYANIDE IN WASTEWATERS FROM INCINERATION AT PLANT A

BDAT List Spike #	Constituent	Original Amount Found* (ppm)	Matrix Spike Amount Spiked (ppm)	Matrix Spike Amount Recovered (ppm)	Matrix Spike Percent Recovery (%) [1]	Matrix Spike Duplicate Amount Spiked (ppm)	Matrix Spike Duplicate Amount Recovered (ppm)	Matrix Spike Duplicate Percent Recovery (%)	Relative Percent Difference (%) [2]
VOLATILES									
24.	1,1-Dichloroethene	ND	0.05	0.032	64	0.05	0.028	56	13
47.	Trichloroethene	ND	0.05	0.051	102	0.05	0.047	94	8
4.	Benzene	0.013	0.05	0.053	80	0.05	0.040	54	39
43.	Toluene	0.045	0.05	0.095	100	0.05	0.050	9	166
9.	Chlorobenzene	ND	0.05	0.055	110	0.05	0.051	101	9
38.	Methylene Chloride	ND	0.05	0.092	184	0.05	0.055	110	50
45.	1,1,1-Trichloroethene	ND	0.05	0.062	124	0.05	0.055	110	12
229.	4-Methyl-2-pentanone	ND	0.05	0.061	122	0.05	0.044	87	33
215. - 217.	Total Xylenes	0.009	0.05	0.057	96	0.05	0.046	73	27
	AVERAGE: [3]				109			86	

1 Percent recovery = 100((Ci-Co)/Ct), where Co is the concentration of the original amount found, Ci is the concentration of the amount recovered, and Ct is the concentration of the amount spiked.

2 Relative percent difference = ((D1-D2)/((D1+D2)/2))100, where D1 is the larger of the two amounts recovered.

3 Percent recoveries less than 20% are not acceptable for this program and were not included in calculating the average percent recovery.

ND Not detected. Detection limits are presented in Appendix D.

* For constituents not detected above the detection limit (ND), the original amount found was considered zero in calculating percent recovery.

Table B-5 (Continued)

MATRIX SPIKE RECOVERIES USED TO CORRECT TREATMENT PERFORMANCE DATA FOR ORGANICS IN NONWASTEWATERS FROM SOLVENT EXTRACTION AT PLANT Q AND FOR CYANIDE IN WASTEWATERS FROM INCINERATION AT PLANT A

BDAT List #	Spike Constituent	Original Amount Found* (ppm)	Matrix Spike Amount Spiked (ppm)	Matrix Spike Amount Recovered (ppm)	Matrix Spike Percent Recovery (%) [1]	Matrix Spike Duplicate Amount Spiked (ppm)	Matrix Spike Duplicate Amount Recovered (ppm)	Matrix Spike Duplicate Percent Recovery (%)	Relative Percent Difference (%) [2]
INORGANICS									
169.	Cyanide	ND	0.1	0.102	102	0.1	0.104	104	1.9
SEMIVOLATILES									
142.	Phenol	1.83	13.3	12.9	83	13.3	10.2	63	27
78.	2-Chlorophenol	ND	13.3	8.14	61	13.3	5.6	42	37
99.	1,4-Dichlorobenzene	ND	6.67	3.05	46	6.64	1.18	18	88
105.	n-Nitroso-di-n-propylamine	ND	6.67	4.14	62	6.64	3.76	57	8
150.	1,2,4-Trichlorobenzene	ND	6.67	3.66	55	6.64	3.09	47	16
76.	4-Chloro-3-methylphenol	ND	13.3	9.2	69	13.3	12.8	96	33
52.	Acenaphthene	ND	6.67	3.75	56	6.64	4.48	67	18
127.	4-Nitrophenol	ND	13.3	8.67	65	13.3	14.6	110	51
102.	2,4-Dinitrotoluene	ND	6.67	4.51	68	6.64	5.54	83	20
139.	Pentachlorophenol	ND	13.3	10.6	80	13.3	12.4	93	15
145.	Pyrene	0.402	6.67	6.2	87	6.64	7.7	110	23
	AVERAGE: [3]				67			77	

[1] Percent recovery = 100((Ci-Co)/Ct), where Co is the concentration of the original amount found, Ci is the concentration of the amount recovered, and Ct is the concentration of the amount spiked.

[2] Relative percent difference = ((D1-D2)/((D1+D2)/2))100, where D1 is the larger of the two amounts recovered.

[3] Percent recoveries less than 20% are not acceptable for this program and were not included in calculating the average percent recovery.

ND Not detected. Detection limits are presented in Appendix D.

* For constituents not detected above the detection limit (ND), the original amount found was considered zero in calculating percent recovery.

Table B-6

LABORATORY DUPLICATE INJECTION ANALYSIS FOR ORGANICS IN NONWASTEWATERS FROM SOLVENT EXTRACTION AT PLANT Q AND FOR CYANIDE IN WASTEWATERS FROM INCINERATION AT PLANT A

BDAT List Spike Constituent	Matrix Spike Sample Result (ppm)	Matrix Spike Duplicate Injection Sample Result (ppm)	Relative Percent Difference* (%)
SEMIVOLATILES			
142. Phenol	12.90	14.70	15
78. 2-Chlorophenol	8.14	8.40	3
99. 1,4-Dichlorobenzene	3.05	3.16	4
105. n-Nitroso-di-n-propylamine	4.14	4.23	3
150. 1,2,4-Trichlorobenzene	3.66	3.76	3
76. 4-Chloro-3-methylphenol	9.20	12.10	27
52. Acenaphthene	3.75	3.80	2
127. 4-Nitrophenol	8.67	10.80	22
102. 2,4-Dinitrotoluene	4.51	5.58	22
139. Pentachlorophenol	10.60	12.00	12
145. Pyrene	6.20	5.80	7
INORGANICS			
169. Cyanide	0.102	NA	NA

* Relative percent difference = ((MS-DI)/(MS+DI)/2)x100, where MS is the sample result for the matrix spike sample and DI is the sample result for the duplicate injection sample.

NA Not analyzed.

Table B-7

CALIBRATION PROCEDURES SPECIFIED IN SW-846 TO ANALYZE
ORGANIC BDAT LIST CONSTITUENTS AND CYANIDE

Analysis	SW-846 method	Standards	Calibration procedures
Gas chromatography/ mass spectrometry (GC/MS) for volatile organics	8240	• The internal standards are bromochloromethane, 1,4-difluorobenzene, and chlorobenzene-d5. The concentration is 50 ug/l.	• The internal standards are added to each sample to check performance of GC/MS.
		• Calibration standards are a mixture of all available BDAT volatile compounds.	• Concentration of standards for calibration curve are 20, 50, 100, 150, and 200 ug/l. Calibration curve is run when continuing calibration does not meet criteria. This meets the requirements in SW-846.
		• Check standard is bromofluorobenzene (BFB).	• Check standard is run every 12 hours as specified in method 8240.
		• Calibration check compounds (CCCs) are chloroform, 1,2-dichloropropane, toluene, ethylbenzene, vinyl chloride and 1,1-dichloroethene.	• CCCs at 50 ug/l are run every 12 hours. This meets the requirements in SW-846.
		• System performance check compounds (SPCCs) are chloromethane, 1,1-dichloroethane, bromoform, 1,1,2,2-tetrachloroethane, and chlorobenzene.	• SPCCs as specified in the method are run initially as specified in the method are run initially to ensure minimum average response factor of 0.3. The concentrations of the SPCCs are at 50 ppb. The SPCCs are repeated every 12 hours. This meets the requirements in SW-846.

Table B-7 (Continued)

CALIBRATION PROCEDURES SPECIFIED IN SW-846 TO ANALYZE
ORGANIC BDAT LIST CONSTITUENTS AND CYANIDE

Analysis	SW-846 method	Standards	Calibration procedures
Gas chromatography/ mass spectrometry for semivolatile organics	8270	• Internal standards used are 1,4-dichlorobenzene-d4, naphthalene-d8, acenaphthene-d10, phenanthrene-d10, chrysene-d12, and perylene-d12.	• The concentration of each internal standard is 40 ug/ml. These standards are added to each sample to check performance of GC/MS. This meets the requirements in SW-846.
		• Calibration standards are a mixture of all available BDAT semivolatile constituents.	• The concentration of standards for calibration are 20, 50, 80, 120, and 160 ug/l. Calibration curve is run when GS/MS system does not meet the daily continuing calibration checks. This meets the requirements in SW-846.
		• Check standard is decafluorotriphenylphosphine (DFTPP).	• Daily checks as specified in SW-846 are completed for DFTPP to determine whether spectrum meets criteria specified in method.
		• The calibration check compounds (CCCs) are phenol, 1,4-dichlorobenzene, 2-nitrophenol, 2,4-dichlorophenol, hexachlorobutadiene, 4-chloro-3-methyl phenol, 2,4,6-trichlorophenol, acenaphthene, benzo(a)pyrene, di-n-octyl phthalate, fluoranthene, N-nitrosodi-N-phenylamine, and pentachlorophenol.	• The CCCs are run every 12 hours. This meets the requirements in SW-846.

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Table B-7 (Continued)

CALIBRATION PROCEDURES SPECIFIED IN SW-846 TO ANALYZE
ORGANIC BDAT LIST CONSTITUENTS AND CYANIDE

Analysis	SW-846 method	Standards	Calibration procedures
		• The system performance check compounds (SPCCs) are N-nitrosodi-n-propylamine, hexachlorocyclopentadiene, 2,4-dinitrophenol, and 4-nitrophenol. These are the SPCCs recommended in SW-846.	• The concentrations of the SPCCs are 50 ug/l. The system performance (i.e., the GC) is verified initially to ensure a minimum average response factor of 0.05 for the SPCCs. The SPCCs are run every 12 hours for duration of project. This meets the requirements in SW-846.
Total and Amenable Cyanide	9010	- Calibration standard was cyanide.	- The five calibration standards used were 0.5, 0.4, 0.3, 0.2, 0.1 mg/l, and a blank. - The calibration curve was run once per day. - The check standard was 0.3 ug/l for all samples. The frequency of running the check standard was 10 percent.

Table B-8

SOURCE AND PURITY OF CALIBRATION STANDARDS

BOAT ref. no.	Constituents	Source for standards	Purity or grade or concentration
	Volatile Organics		
222	Acetone	Supelco	200 µg/ml
1	Acetonitrile	Chem Service	99+
2	Acrolein	Chem Service	97%
3	Acrylonitrile	Chem Service	99+%
4	Benzene	Supelco	200 µg/ml
5	Bromodichloromethane	Supelco	200 µg/ml
6	Bromomethane	Supelco	200 µg/ml
7	Carbon tetrachloride	Supelco	200 µg/ml
8	Carbon disulfide	Supelco	200 µg/ml
9	Chlorobenzene	Supelco	200 µg/ml
10	2-Chloro-1,3-butadiene	Alfa Products	Reagent Grade
11	Chlorodibromomethane	Supelco	200 µg/ml
12	Chloroethane	Supelco	200 µg/ml
13	2-Chloroethyl vinyl ether	Chem Service	99%
14	Chloroform	Supelco	200 µg/ml
15	Chloromethane	Supelco	200 µg/ml
16	3-Chloropropene	Aldrich	99%
17	1,2-Dibromo-3-chloropropane	Chem Service	Reagent Grade
18	1,2-Dibromoethane	Chem Service	99+%
19	Dibromomethane	Aldrich	99%
20	trans-1,4-Dichloro-2-butene	Aldrich	85+%
21	Dichlorodifluoromethane	Supelco	200 µg/ml
22	1,1-Dichloroethane	Supelco	200 µg/ml
23	1,2-Dichloroethane	Supelco	200 µg/ml
24	1,1-Dichloroethylene	Supelco	200 µg/ml
25	trans-1,2-Dichloroethene	Supelco	200 µg/ml
26	1,2-Dichloropropane	Supelco	200 µg/ml
27	trans-1,3-Dichloropropene	Supelco	200 µg/ml
28	cis-1,3-Dichloropropene	Supelco	200 µg/ml
29	1,4-Dioxane	Aldrich	Reagent Grade
228	Ethyl benzene	Supelco	200 µg/ml
30	Ethyl cyanide	Aldrich	Reagent Grade
31	Ethyl methacrylate	Aldrich	99%
214	Ethylene oxide	Eastman	99.7%
32	Iodomethane	Alfa Research Chem.	99%
33	Isobutyl alcohol	Aldrich	99+%
34	Methyl ethyl ketone	Supelco	200 µg/ml
229	Methyl isobutyl ketone	Supelco	200 µg/ml
35	Methyl methacrylate	Chem Service	99+%

Table B-8 (Continued)

SOURCE AND PURITY OF CALIBRATION STANDARDS

BOAT ref. no.	Constituents	Source for standards	Purity or grade or concentration
	Volatile Organics (continued)		
37	Methylacrylonitrile	Aldrich	Reagent Grade
38	Methylene chloride	Supelco	200 µg/ml
39	Pyridine	Chem Service	99%
40	1,1,1,2-Tetrachloroethane	Chem Service	Reagent Grade
41	1,1,2,2-Tetrachloroethane	Supelco	200 µg/ml
42	Tetrachloroethene	Supelco	200 µg/ml
43	Toluene	Supelco	200 µg/ml
44	Tribromomethane	Supelco	200 µg/ml
45	1,1,1-Trichloroethane	Supelco	200 µg/ml
46	1,1,2-Trichloroethane	Supelco	200 µg/ml
47	Trichloroethene	Supelco	200 µg/ml
48	Trichloromonofluoromethane	Supelco	200 µg/ml
49	1,2,3-Trichloropropane	Chem Service	99+%
50	Vinyl chloride	Supelco	200 µg/ml
215-217	Xylenes	Supelco	200 µg/ml
	Semivolatile Organics		
51	Acenaphthylene	EPA	2 mg/ml
52	Acenaphthene	EPA	2 mg/ml
53	Acetophenone	Aldrich	99%
54	2-Acetylaminofluorene	Aldrich	Reagent Grade
55	4-Aminobiphenyl	Aldrich	98%
56	Aniline	Chem Service	Reagent Grade
57	Anthracene	EPA	2 mg/ml
58	Aramite	Chem Service	90%
59	Benz(a)anthracene	EPA	2 mg/ml
60	Benzenethiol	Aldrich	Regent Grade
62	Benzo(a)pyrene	EPA	2 mg/ml
63	Benzo(b)fluoranthene	EPA	2 mg/ml
64	Benzo(ghi)perylene	EPA	2 mg/ml
65	Benzo(k)fluoranthene	EPA	2 mg/ml
66	p-Benzoquinone	Chem Service	Reagent Grade
67	Bis(2-chloroethoxy)methane	Pfaltz-Bauer	Reagent Grade
68	Bis(2-chloroethyl)ether	EPA	2 mg/ml
69	Bis(2-chloroisopropyl)ether	Chem Service	97.6%
70	Bis(2-ethylhexyl)phthalate	EPA	2 mg/ml
71	4-Bromophenyl phenyl ether	EPA	2 mg/ml
72	Butyl benzyl phthalate	EPA	2 mg/ml

Table B-8 (Continued)

SOURCE AND PURITY OF CALIBRATION STANDARDS

BDAT ref. no.	Constituents	Source for standards	Purity or grade or concentration
	Semivolatile Organics (continued)		
73	2-sec-Butyl-4,6-dinitrophenol	Chem Service	99%
74	p-Chloroaniline	EPA	2 mg/ml
75	Chlorobenzilate	Chem Service	96%
76	p-Chloro-m-cresol	EPA	2 mg/ml
77	2-Chloronaphthalene	Aldrich	90%
78	2-Chlorophenol	EPA	2 mg/ml
80	Chrysene	Eastman Kodak	Reagent Grade
81	ortho-Cresol	EPA	2 mg/ml
82	para-Cresol	EPA	2 mg/ml
83	Dibenz(a,h)anthracene	EPA	2 mg/ml
84	Dibenzo(a,e)pyrene	Sigma Chemical	98%
86	m-Dichlorobenzene	EPA	2 mg/ml
87	o-Dichlorobenzene	EPA	2 mg/ml
88	p-Dichlorobenzene	EPA	2 mg/ml
89	3,3'-Dichlorobenzidine	EPA	2 mg/ml
90	2,4-Dichlorophenol	EPA	2 mg/ml
91	2,6-Dichlorophenol	EPA	2 mg/ml
92	Diethyl phthalate	EPA	2 mg/ml
93	3,3'-Dimethoxybenzidine	Aldrich	97%
94	p-Dimethylaminoazobenzene	Aldrich	Reagent Grade
95	3,3'-Dimethylbenzidine	EM Science	Reagent Grade
96	2,4-Dimethylphenol	EPA	2 mg/ml
97	Dimethyl phthalate	EPA	2 mg/ml
98	Di-n-butyl phthalate	EPA	2 mg/ml
99	1,4-Dinitrobenzene	Aldrich	98%
100	4,6-Dinitro-o-cresol	EPA	2 mg/ml
101	2,4-Dinitrophenol	EPA	2 mg/ml
102	2,4-Dinitrotoluene	EPA	2 mg/ml
103	2,6-Dinitrotoluene	EPA	2 mg/ml
104	Di-n-octyl phthalate	EPA	2 mg/ml
105	Di-n-propylnitrosamine	EPA	2 mg/ml
106/	Diphenylamine/	Aldrich	99%
219	Diphenylnitrosamine	Eastman Kodak	Reagent Grade
107	1,2-Diphenylnitrosamine	Chem Service	99+%
108	Fluoranthene	EPA	2 mg/ml
109	Fluorene	EPA	2 mg/ml
110	Hexachlorobenzene	EPA	2 mg/ml
111	Hexachlorobutadiene	EPA	2 mg/ml
112	Hexachlorocyclopentadiene	EPA	2 mg/ml
113	Hexachloroethane	EPP	2 mg/ml

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Table B-8 (Continued)

SOURCE AND PURITY OF CALIBRATION STANDARDS

BOAT ref. no.	Constituents	Source for standards	Purity or grade or concentration
	Semivolatile Organics (continued)		
114	Hexachlorophene	Chem Service	Reagent Grade
115	Hexachloropropene	Aldrich	96%
116	Indeno(1,2,3-cd)pyrene	EPA	2 mg/ml
117	Isosafrole	Fluka	95%
118	Methapyrilene	Sigma Chemical	Reagent Grade
119	3-Methylcholanthrene	Aldrich	98%
120	4,4'-Methylenebis (2-chloroaniline)	Chem Service	Reagent Grade
36	Methyl methanesulfonate	Aldrich	99%
121	Naphthalene	EPA	2 mg/ml
122	1,4-Naphthoquinone	Aldrich	97%
123	1-Naphthylamine	Chem Service	Reagent Grade
124	2-Naphthylamine	Aldrich	Reagent Grade
125	p-Nitroaniline	EPA	2 mg/ml
126	Nitrobenzene	EPA	2 mg/ml
127	4-Nitrophenol	EPA	2 mg/ml
128	N-Nitrosodi-n-butylamine	Chem Service	Reagent Grade
129	N-Nitrosodiethylamine	Chem Service	Reagent Grade
130	N-Nitrosodimethylamine	Chem Service	Reagent Grade
131	N-Nitrosomethylethylamine	Chem Service	Reagent Grade
132	N-Nitrosomorpholine	Chem Service	Reagent Grade
133	N-Nitrosopiperidine	Chem Service	Reagent Grade
134	n-Nitrosopyrrolidine	Aldrich	99%
135	5-Nitro-o-toluidine	Chem Service	High Purity
136	Pentachlorobenzene	Chem Service	Reagent Grade
137	Pentachloroethane	Aldrich	96%
138	Pentachloronitrobenzene	Chem Service	98%
139	Pentachlorophenol	EPA	2 mg/ml
140	Phenacetin	Chem Service	97%
141	Phenanthrene	Chem Service	High Purity
142	Phenol	EPA	2 mg/ml
143	2-Picoline	Aldrich	98%
144	Pronamide	Chem Service	98%
145	Pyrene	EPA	2 mg/ml
146	Resorcinol	Aldrich	98%
147	Safrole	Aldrich	97%
148	1,2,4,5-Tetrachlorobenzene	Aldrich	98%
149	2,3,4,6-Tetrachlorophenol	Chem Service	92%
150	1,2,4-Trichlorobenzene	EPA	2 mg/ml
151	2,4,5-Trichlorophenol	EPA	2 mg/ml
152	2,4,6-Trichlorophenol	EPA	2 mg/ml
153	Tris(2,3-dibromopropyl) phosphate	Chem Service	Reagent Grade
	INORGANICS		
189	Cyanide	Fisher 743410	***

Table B-9

SOURCE AND/OR PURITY OF SYSTEM PERFORMANCE CHECK COMPOUNDS AND CALIBRATION CHECK STANDARDS

Compound	Source	Purity/grade
System Performance Check Compounds for Method 8240		
Chloromethane	Supelco	200 µg/ml
1,1-Dichloroethane	Supelco	200 µg/ml
Bromoform	Supelco	200 µg/ml
1,1,2,2-Tetrachloroethane	Supelco	200 µg/ml
Chlorobenzene	Supelco	200 µg/ml
Calibration Check Compounds for Method 8240		
1,1-Dichloroethene	Supelco	200 µg/ml
Chloroform	Chem Service	200 µg/ml
1,2-Dichloropropane	Chem Service	200 µg/ml
Toluene	KOR	200 µg/ml
Ethylbenzene	Chem Service	200 µg/ml
Vinyl chloride	EPA Materials Bank	200 µg/ml
Internal Standards for Method 8240		
Bromochloromethane	Supelco	1,000 µg/ml
1,4-Difluorobenzene	Aldrich	1,000 µg/ml
Chlorobenzene-d5	KOR	1,000 µg/ml
Surrogates for Method 8240		
Toluene-d8	Supelco	250 µg/l
Bromofluorobenzene	Supelco	250 µg/l
1,2-Dichloroethane-d4	Supelco	250 µg/l

Table B-9 (Continued)

SOURCE AND/OR PURITY OF SYSTEM PERFORMANCE CHECK
COMPOUNDS AND CALIBRATION CHECK STANDARDS

Compound	Source	Purity/grade
System Performance Check Compounds for Method 8270		
N-Nitrosodi-n-propylamine	EPA	2 mg/ml
Hexachlorocyclopentadiene	EPA	2 mg/ml
2,4-Dinitrophenol	EPA	2 mg/ml
4-Nitrophenol	EPA	2 mg/ml
Calibration Check Compounds for Method 8270		
Acenaphthene	EPA	2 mg/ml
1,4-Dichlorobenzene	EPA	2 mg/ml
Hexachlorobutudiene	EPA	2 mg/ml
N-Nitrosodiphenyl amine	EPA	2 mg/ml
Di-n-octyl phthalate	EPA	2 mg/ml
Benzo(a)pyrene	EPA	2 mg/ml
4-Chloro-3-methylphenol	EPA	2 mg/ml
2,4-Dichlorophenol	EPA	2 mg/ml
2-Nitrophenol	EPA	2 mg/ml
Phenol	EPA	2 mg/ml
Pentachlorophenol	EPA	2 mg/ml
2,4,6-Trichlorophenol	EPA	2 mg/ml
Fluoranthene	EPA	2 mg/ml
Internal Standards for Method 8270		
1,4-Dichlorobenzene-d4	KOR	98%
Naphthalene-d8	KOR	99%
Acenaphthalene-d10	KOR	98%
Phenanthrene-d10	KOR	98%
Chrysene-d12	KOR	98%
Perylene-d12	KOR	98%
Surrogates for Method 8270		
Nitrobenzene-d5	KOR	99%
2-Fluorobiphenyl	Aldrich	97%
Terphenyl-d14	ICN	98%
Phenol-d6	Cambridge Isotope Labs	98%
2-Fluorophenol	Aldrich	97%
2,4,6-Tribromophenol	Chem Service	Reagent Grade

Table B-10

PURITY OF SOLVENTS AND ACIDS USED

Compound	Purity or quality
Solvents	
Methylene chloride	Pesticide/capillary grade[a]
Hexane	GC/capillary grade
2-Propanol	Pesticide/capillary grade
Cyclohexane	Pesticide/capillary grade
Methanol	GC/MS grade
Acids	
Hydrochloric acid	Fisher reagent grade
Sulfuric acid	Fisher reagent grade
Nitric acid	Baker Insta-analyzed
Acetic acid	Fisher reagent grade

[a]The pesticide/capillary grade methylene chloride is redistilled in glass to eliminate any impurities that may be present in the solvent.

Note: Reagent water is deionized by Versar's in-house system then distilled in glass, and finally purged while hot with high purity (99.9999%) helium.

Table B-11

SUMMARY OF ACCURACY CORRECTION FACTORS
FOR ORGANICS IN NONWASTEWATERS AND CYANIDE IN WASTEWATERS

BDAT List No.	BDAT List Constituent	Accuracy Correction Factor @
	VOLATILES	
4.	Benzene	1.852
226.	Ethylbenzene #	1.163
43.	Toluene #	1
215.-217.	Xylene (total)	1.37
	SEMIVOLATILES	
57.	Anthracene	1.493 *
59.	Benz(a)anthracene	1.493 *
121.	Napthalene	1.493 *
62.	Benzo(a)pyrene	1.493 *
145.	Pyrene	1.149
80.	Chrysene	1.493 *
142.	Phenol	1.587
141.	Phenanthrene	1.493 *
	INORGANICS	
169.	Cyanide	1

@ The accuracy correction factor is equal to 100 divided by the percent recovery.

* No matrix spike was performed for this constituent. The percent recovery for this constituent is based on the lower average percent recovery of the matrix spike and matrix spike duplicate for the semivolatile constituents.

\# The matrix spike duplicate recovery for toluene was 9%. Recoveries less than 20% are not acceptable for the BDAT program and are not included in calculating accuracy correction factors as discussed in Reference 41.

APPENDIX C

STATISTICAL COMPARISON OF DATA SETS FOR K048-K052 NONWASTEWATER METAL CONSTITUENTS

STATISTICAL COMPARISON OF DATA SETS FOR K048-K052 NONWASTEWATER METAL CONSTITUENTS

A statistical test was used to compare the treatment performance achieved by Plants I, R, U, and X for stabilization of metals in K048-K052 treatment residuals. Results of the statistical comparison are presented in Tables C-1 through C-3. As demonstrated in Table C-1, the data from Plants X and R (stabilization of solvent extraction raffinate) showed overall better treatment for metal constituents in K048-K052.

A statistical comparison of treatment performance could not be performed for selenium because no data were available from Plants R, U, or X for this constituent. As discussed in Section 5.0, the Agency is deleting selenium as a regulated constituent in nonwastewater forms of K048-K052.

A nonparametric approach was used to perform the statistical comparison of these data. This approach is an alternative statistical method to the analysis of variance (ANOVA) test discussed in EPA's Methodology for Developing BDAT Treatment Standards (Reference 41). The major assumptions made in performing an ANOVA are: (1) the errors have a mean of zero, and (2) the errors are independent and normally distributed. It was difficult to assess whether the stabilization data met the above criteria, since so little data were available and some of the results were below the detection limit. Finally, the treated waste data being compared included a number of different levels of detection limits.

A nonparametric approach is an alternative approach which circumvents some of these problems. This approach involves no assumptions about the underlying distribution of the data. Instead, the nonparametric approach involves ranking, or categorizing, the data and performing the standard statistical tests on the ranks or categories. A nonparametric version of the ANOVA and Duncan's Multiple-Range test were performed to compare the stabilization treatment performance data from Plants I, R, U, and X. ANOVA's are used to determine whether differences among several means are

significant, however, they do not determine which given means (or group of means) are significantly higher or lower than the others. A multiple range test can be used to determine which group means are higher or lower than the others, given that there is a significant difference between the means. For example, an ANOVA performed on the metals data may conclude that the mean analyte concentrations are different treatment types. When the treatment means differed significantly, Duncan's Multiple-Range test was then used to determine which treatments had mean concentrations which were significantly higher or lower than the other treatments. (This approach still does not always adequately deal with the problem of multiple detection limits in the treatments being compared, since "not detected" values are ranked according to the value of the detection limit.)

Table C-1

SUMMARY OF STATISTICAL COMPARISON OF DATA SETS FOR NONWASTEWATER METALS *

BDAT List Constituent	RANKING OF DATA SETS** Best Data Set	Second Best Data Set	Third Best Data Set	Fourth Best Data Set	Fifth Best Data Set	Comments
Arsenic	Plant R and Plant I	Plant Ua	Plant Ub			No data were available from Plant X for this constituent.
Chromium (total)	Plant R and Plant X	Plant Ua and Plant Ub	Plant I			
Nickel	Plant I and Plant X	Plant R, Plant Ua, and Plant Ub				
Selenium	Plant I					No data were available from Plants R, U, or X for this constituent.
OVERALL RANKING	Plant X	Plant R	Plant I	Plant Ua	Plant Ub	

* See Appendix A for plant codes.
** Plant Ua - lime/fly ash stabilization of K048 and K051 incinerator ash.
Plant Ub - lime/fly ash/C/F stabilization of K048 and K051 incinerator ash.

Table C-2

Metals Data and Ranks

ANALYTE-ARSENIC

Run Num.	Amoco1 Result	Amoco1 Rank	Amoco2 Result	Amoco2 Rank	BP Result	BP Rank	EPA Result	EPA Rank	EXXON Result	EXXON Rank
1	0.008	10.5	0.021	18.0	.	.	<0.004	2.5	0.004	6
2	0.008	10.5	0.015	17.0	.	.	<0.004	2.5	<0.003	1
3	0.008	10.5	0.092	20.0	.	.	0.006	8.0	<0.006	4
4	0.010	14.0	0.08	19.0	.	.	.	.	.	.
5	0.011	15.0	.	.	.	.	.	.	.	.
6	<0.008	6.0	.	.	.	.	.	.	.	.
7	0.009	13.0	.	.	.	.	.	.	.	.
8	0.013	16.0	.	.	.	.	.	.	.	.
9	0.008	10.5	.	.	.	.	.	.	.	.
10	<0.008	6.0	.	.	.	.	.	.	.	.

ANALYTE-CHROMIUM

Run Num.	Amoco1 Result	Amoco1 Rank	Amoco2 Result	Amoco2 Rank	BP Result	BP Rank	EPA Result	EPA Rank	EXXON Result	EXXON Rank
1	0.47	8.0	1.010	15.0	<0.05	3		.	.	.
2	0.99	14.0	0.054	7.0	<0.05	3	1.47	21	<0.10	6
3	0.61	9.5	0.610	9.5	<0.05	3	1.57	22	<0.05	3
4	1.11	19.0	1.100	18.0	<0.05	3	1.4	20	.	.
5	1.04	17.0	.	.	.	.	.	.	.	.
6	0.98	13.0	.	.	.	.	.	.	.	.
7	1.03	16.0	.	.	.	.	.	.	.	.
8	0.71	11.0	.	.	.	.	.	.	.	.
9	0.86	12.0	.	.	.	.	.	.	.	.

ANALYTE-NICKEL

Run Num.	Amoco1 Result	Amoco1 Rank	Amoco2 Result	Amoco2 Rank	BP Result	BP Rank	EPA Result	EPA Rank	EXXON Result	EXXON Rank
1	0.061	7.0	0.113	20.0	<0.04	4	<0.026	2.5	.	.
2	0.097	11.5	0.108	18.5	0.05	5	<0.026	2.5	0.15	24
3	0.097	11.5	0.314	25.0	0.06	6	<0.020	1.0	0.13	22
4	0.101	16.0	0.097	11.5	0.07	8	.	.	0.1	15
5	0.099	14.0	.	.	.	.	.	.	.	.
6	0.104	17.0	.	.	.	.	.	.	.	.
7	0.108	18.5	.	.	.	.	.	.	.	.
8	0.129	21.0	.	.	.	.	.	.	.	.
9	0.096	9.0	.	.	.	.	.	.	.	.
10	0.097	11.5	.	.	.	.	.	.	.	.
11	0.138	23.0	.	.	.	.	.	.	.	.

Table C-3
bdat
Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=ARSENIC ----------

General Linear Models Procedure
Class Level Information

Class	Levels	Values
SOURCE	5	AMOCO1 AMOCO2 BP EPA EXXON

Number of observations in by group = 50

NOTE: Due to missing values, only 20 observations can be used in this analysis.

Table C-3 (Continued)

bdat
Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=ARSENIC ----------

General Linear Models Procedure

Dependent Variable: RCONC RANK FOR VARIABLE CON2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	560.66666667	186.88888889	35.46	0.0001
Error	16	84.33333333	5.27083333		
Corrected Total	19	645.00000000			

R-Square	C.V.	Root MSE	RCONC Mean
0.869251	21.86504	2.2958296	10.50000000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SOURCE	3	560.66666667	186.88888889	35.46	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SOURCE	3	560.66666667	186.88888889	35.46	0.0001

Table C-3 (Continued)

bdat

Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=ARSENIC ----------

General Linear Models Procedure

Duncan's Multiple Range Test for variable: RCONC

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

Alpha= 0.05 df= 16 MSE= 5.270833
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 3.934426

Number of Means	2	3	4
Critical Range	3.464	3.635	3.753

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	SOURCE
A	18.500	4	AMOCO2
B	11.500	10	AMOCO1
C	3.833	3	EPA
C			
C	3.167	3	EXXON

Table C-3 (Continued)

bdat

Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=CHROMIUM ----------

General Linear Models Procedure
Class Level Information

Class	Levels	Values
SOURCE	5	AMOCO1 AMOCO2 BP EPA EXXON

Number of observations in by group = 45

NOTE: Due to missing values, only 22 observations can be used in this analysis.

Table C-3 (Continued)

bdat

Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=CHROMIUM ----------

General Linear Models Procedure

Dependent Variable: RCONC RANK FOR VARIABLE CON2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	674.25694444	168.56423611	14.27	0.0001
Error	17	200.74305556	11.80841503		
Corrected Total	21	875.00000000			

R-Square	C.V.	Root MSE	RCONC Mean
0.770579	29.88120	3.4363374	11.50000000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SOURCE	4	674.25694444	168.56423611	14.27	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SOURCE	4	674.25694444	168.56423611	14.27	0.0001

Table C-3 (Continued)

bdat

Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=CHROMIUM ----------

General Linear Models Procedure

Duncan's Multiple Range Test for variable: RCONC

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

Alpha= 0.05 df= 17 MSE= 11.80842
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 3.461538

Number of Means	2	3	4	5
Critical Range	5.502	5.775	5.963	6.069

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	SOURCE
A	21.000	3	EPA
B	13.278	9	AMOCO1
B			
B	12.125	4	AMOCO2
C	5.000	2	EXXON
C			
C	3.000	4	BP

Table C-3 (Continued)

bdat

Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=NICKEL ----------

General Linear Models Procedure
Class Level Information

Class	Levels	Values
SOURCE	5	AMOCO1 AMOCO2 BP EPA EXXON

Number of observations in by group = 55

NOTE: Due to missing values, only 25 observations can be used in this analysis.

Table C-3 (Continued)

bdat

Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=NICKEL ----------

General Linear Models Procedure

Dependent Variable: RCONC RANK FOR VARIABLE CON2

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	893.10606061	223.27651515	11.14	0.0001
Error	20	400.89393939	20.04469697		
Corrected Total	24	1294.00000000			

R-Square	C.V.	Root MSE	RCONC Mean
0.690190	34.43946	4.4771304	13.00000000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
SOURCE	4	893.10606061	223.27651515	11.14	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SOURCE	4	893.10606061	223.27651515	11.14	0.0001

Table C-3 (Continued)

bdat

Comparison of 5 Treatments by Analyte Using ANOVA
Nonparametric Approach

---------- ANALYTE=NICKEL ----------

General Linear Models Procedure

Duncan's Multiple Range Test for variable: RCONC

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

Alpha= 0.05 df= 20 MSE= 20.0447
WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes= 3.975904

Number of Means	2	3	4	5
Critical Range	6.615	6.947	7.176	7.310

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	SOURCE
A	20.333	3	EXXON
A			
A	18.750	4	AMOCO2
A			
A	14.545	11	AMOCO1
B	5.750	4	BP
B			
B	2.000	3	EPA

Appendix D

DETECTION LIMITS FOR UNTREATED AND TREATED WASTES

DETECTION LIMITS FOR UNTREATED AND TREATED WASTES

Statistical tests were conducted to compare the treatment performance achieved by the three-cycle solvent extraction unit at plant M with treatment performance achieved by the extraction unit at Plant Q. Results of the statistical tests are summarized in Tables C-1 through C-3. Based on these calculations, the system at Plant Q performed significantly better than the system at Plant M for the following regulated constituents in K048-K052 nonwastewaters: anthracene, benz(a)anthracene, chrysene, di-n-butyl phthalate, ethylbenzene, phenanthrene, pyrene, toluene, and o-cresol. The system at Plant M performed significantly better than the system at Plant Q for the following regulated constituents: phenol and p-cresol.

A statistical comparison of treatment performance by the systems at Plants Q and M could not performed for xylene and naphthalene because the treatment system at Plant M does not show treatment for xylene and naphthalene. The treatment system at Plant Q does demonstrate significant treatment for these constituents.

The Wilcoxon rank-sum test (Statistical Methods, Snedecor, G.W. and Cochran, W.G., 7th ed., p. 144) was used to perform the statistical comparison of these data. This test is an alternative statistical approach to the analysis of variance (ANOVA) test discussed in EPA's Methodology for Developing BDAT Treatment Standards (Reference 41). Two basic assumptions are made in performing an ANOVA: (1) the data are normally distributed and (2) the variances from the data sets being compared are homogeneous. Due to the relatively small number of data points and the fact that a majority of the treated waste data consisted of non-detect values, it was difficult to assess whether these criteria were met. An alternative statistical approach which circumvents these problems is a non-parametric approach; this approach involves no assumptions about the underlying distribution of the data. Instead, the non-parametric approach involves ranking, or categorizing, the data and performing statistical tests on these ranks or categories. The non-parametric

Wilcoxon rank-sum test basically consists of performing an ANOVA on the ranks of the data. Accordingly, the Wilcoxon rank-sum test was determined to be the appropriate method to use to compare the treatment performance data from the treatment systems at Plants M and Q.

TABLE D-1

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

	BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
	VOLATILE ORGANICS				
222.	Acetone	5	10	10	6.3
1.	Acetonitrile	50	100	100	63
2.	Acrolein	25	50	50	31
3.	Acrylonitrile	25	50	50	31
4.	Benzene	2.5	5	5	3.1
5.	Bromodichloromethane	2.5	5	5	3.1
6.	Bromomethane	5	10	10	6.3
223.	n-Butyl alcohol	100	200	200	125
7.	Carbon tetrachloride	2.5	5	5	3.1
8.	Carbon disulfide	2.5	5	5	3.1
9.	Chlorobenzene	2.5	5	5	3.1
10.	2-Chloro-1,3-butadiene (chloroprene)	2.5	5	5	3.1
11.	Chlorodibromomethane	2.5	5	5	3.1
12.	Chloroethane	5	10	10	6.3
14.	Chloroform	2.5	5	5	3.1
15.	Chloromethane	5	10	10	6.3
16.	3-Chloropropene (allyl chloride)	2.5	5	5	3.1
17.	1,2-Dibromo-3-chloropropane	5	10	10	6.3
18.	1,2-Dibromoethane	2.5	5	5	3.1
19.	Dibromomethane (methylene bromide)	2.5	5	5	3.1
20.	Trans-1,4-dichloro-2-butene	5	10	10	6.3
21.	Dichlorodifluoromethane	5	10	10	6.3
22.	1,1-Dichloroethane	2.5	5	5	3.1
23.	1,2-Dichloroethane	2.5	5	5	3.1
24.	1,1-Dichloroethylene	2.5	5	5	3.1
25.	Trans-1,2-dichloroethene	3.1	3.1	3.1	3.1
26.	1,2-Dichloropropane	2.5	5	5	3.1
27.	Trans-1,3-dichloropropene	2.5	5	5	31
28.	cis-1,3-Dichloropropene	2.5	5	5	3.1
29.	1,4-Dioxane	100	200	200	130
225.	Ethyl acetate	10	20	20	13
226.	Ethyl benzene	2.5	5	5	3.1

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
VOLATILE ORGANICS (Continued)				
30. Ethyl cyanide (propionitrile)	2.5	5	5	3.1
227. Ethyl ether	2.5	5	5	3.1
31. Ethyl methacrylate	2.5	5	5	3.1
32. Iodomethane	2.5	5	5	3.1
33. Isobutyl alcohol	250	500	500	310
34. Methyl ethyl ketone	5	10	10	6.3
229. Methyl isobutyl ketone	5	10	10	6.3
35. Methyl methacrylate	2.5	5	5	3.1
37. Methylacrylonitrile	2.5	5	5	3.1
38. Methylene chloride	2.5	5	5	3.1
39. Pyridine	130	250	250	160
40. 1,1,1,2-Tetrachloroethane	2.5	5	5	3.1
41. 1,1,2,2-Tetrachloroethane	2.5	5	5	3.1
42. Tetrachloroethene	2.5	5	5	3.1
43. Toluene	2.5	5	5	3.1
44. Tribromomethane (bromoform)	2.5	5	5	3.1
45. 1,1,1-Trichloroethane	2.5	5	5	3.1
46. 1,1,2-Trichloroethane	2.5	5	5	3.1
47. Trichloroethene	2.5	5	5	3.1
48. Trichloromonofluoromethane	2.5	5	5	3.1
49. 1,2,3-Trichloropropane	2.5	5	5	3.1
231. 1,1,2-Trichloro-1,2,2-trifluoroethane	2.5	5	5	3.1
50. Vinyl chloride	5	10	10	6.3
215.-217. Xylenes (total)	2.5	5	5	3.1
* 2-Nitropropane	10	20	20	13
* Styrene	2.5	5	5	3.1
* 2-Hexanone	5	10	10	6.3
* Vinyl acetate	5	10	10	6.3
* 1,2-Dichloroethene (total)	2.5	5	5	3.1

* Not a BDAT List constituent.

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT		DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
SEMIVOLATILE ORGANICS					
51.	Acenaphthalene	1.36	1.28	2.72	1.36
52.	Acenaphthene	1.36	1.28	2.72	1.36
53.	Acetophenone	1.36	1.28	2.72	1.36
54.	2-Acetylaminofluorene	1.36	1.28	2.72	1.36
233.	Acrylamide	1.36	1.28	2.72	1.36
55.	4-Aminobiphenyl	1.36	1.28	2.72	1.36
56.	Aniline	1.36	1.28	2.72	1.36
57.	Anthracene	1.36	1.28	2.72	1.36
58.	Aramite	1.36	1.28	2.72	1.36
59.	Benz(a)anthracene	1.36	1.28	2.72	1.36
218.	Benzal chloride	1.36	1.28	2.72	1.36
60.	Benzenethiol	1.36	1.28	2.72	1.36
62.	Benzo(a)pyrene	1.36	1.28	2.72	1.36
63.	Benzo(b)fluoranthene	1.36	1.28	2.72	1.36
64.	Benzo(g,h,i)perylene	1.36	1.28	2.72	1.36
65.	Benzo(k)fluoranthene	1.36	1.28	2.72	1.36
66.	p-Benzoquinone	1.36	1.28	2.72	1.36
67.	Bis(2-chloroethoxy)methane	1.36	1.28	2.72	1.36
68.	Bis(2-chloroethyl)ether	1.36	1.28	2.72	1.36
69.	Bis(2-chloroisopropyl)ether	1.36	1.28	2.72	1.36
71.	4-Bromophenyl phenyl ether	1.36	1.28	2.72	1.36
70.	Bis(2-ethylhexyl)phthalate	1.36	1.28	2.72	1.36
72.	Butyl benzyl phthalate	1.36	1.28	2.72	1.36
73.	2-sec-butyl-4,6-Dinitrophenol (dinoseb)	1.36	1.28	2.72	1.36
74.	p-Chloroaniline	1.36	1.28	2.72	1.36
75.	Chlorobenzilate	1.36	1.28	2.72	1.36
76.	p-Chloro-m-cresol	1.36	1.28	2.72	1.36
77.	2-Chloronaphthalene	1.36	1.28	2.72	1.36
78.	2-Chlorophenol	1.36	1.28	2.72	1.36
80.	Chrysene	1.36	1.28	2.72	1.36
81.	ortho-Cresol	1.36	1.28	2.72	1.36
82.	para-Cresol	1.36	1.28	2.72	1.36
232.	Cyclohexanone	100	200	200	125

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT		DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
SEMIVOLATILE ORGANICS (Continued)					
83.	Dibenz(a,h)anthracene	1.36	1.28	2.72	1.36
84.	Dibenzo(a,e,)pyrene	1.36	1.28	2.72	1.36
86.	m-Dichlorobenzene	1.36	1.28	2.72	1.36
87.	o-Dichlorobenzene	1.36	1.28	2.72	1.36
88.	p-Dichlorobenzene	1.36	1.28	2.72	1.36
89.	3,3'-Dichlorobenzidine	2.72	2.56	5.44	2.72
90.	2,4-Dichlorophenol	1.36	1.28	2.72	1.36
91.	2,6-Dichlorophenol	1.36	1.28	2.72	1.36
92.	Diethyl phthalate	1.36	1.28	2.72	1.36
93.	3,3'-Dimethoxybenzidine	1.36	1.28	5.44	1.36
94.	p-Dimethylaminoazobenzene	1.36	1.28	2.72	1.36
95.	3,3'-Dimethylbenzidine	1.36	1.28	2.72	1.36
96.	2,4-Dimethylphenol	1.36	1.28	2.72	1.36
98.	Di-n-butyl phthalate	1.36	1.28	2.72	1.36
97.	Dimethyl phthalate	1.36	1.28	2.72	1.36
99.	1,4-Dinitrobenzene	1.36	1.28	2.72	1.36
100.	4,6-Dinitro-o-cresol	6.8	6.4	13.6	6.8
101.	2,4-Dinitrophenol	6.8	6.4	13.6	6.8
102.	2,4-Dinitrotoluene	1.36	1.28	2.72	1.36
103.	2,6-Dinitrotoluene	1.36	1.28	2.72	1.36
104.	Di-n-octyl phthalate	1.36	1.28	2.72	1.36
105.	Di-n-propylnitrosamine	1.36	1.28	2.72	1.36
106.	Diphenylamine	1.36	1.28	2.72	1.36
219.	Diphenylnitrosamine	1.36	1.28	2.72	1.36
107.	1,2-Diphenylhydrazine	1.36	1.28	2.72	1.36
108.	Fluoranthene	1.36	1.28	2.72	1.36
109.	Fluorene	1.36	1.28	2.72	1.36
110.	Hexachlorobenzene	1.36	1.28	2.72	1.36
111.	Hexachlorobutadiene	1.36	1.28	2.72	1.36
112.	Hexachlorocyclopentadiene	1.36	1.28	2.72	1.36
113.	Hexachloroethane	1.36	1.28	2.72	1.36
115.	Hexachloropropene	1.36	1.28	2.72	1.36
116.	Indeno(1,2,3-cd)pyrene	1.36	1.28	2.72	1.36
117.	Isosafrole	1.36	1.28	2.72	1.36
118.	Methapyrilene	1.36	1.28	2.72	1.36
119.	3-Methylcholanthrene	1.36	1.28	2.72	1.36
120.	4,4'-Methylenebis(2-chloroaniline)	1.36	1.28	2.72	1.36

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

	BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
	SEMIVOLATILE ORGANICS (Continued)				
36.	Methyl methanesulfonate	1.36	1.28	2.72	1.36
121.	Naphthalene	1.36	1.28	2.72	1.36
122.	1,4-Naphthoquinone	1.36	1.28	2.72	1.36
123.	1-Naphthylamine	1.36	1.28	2.72	1.36
124.	2-Naphthylamine	1.36	1.28	2.72	1.36
125.	p-Nitroaniline	6.8	6.4	13.6	6.8
126.	Nitrobenzene	1.36	1.28	2.72	1.36
127.	4-Nitrophenol	6.8	6.4	13.6	6.8
128.	N-Nitrosodi-n-butylamine	1.36	1.28	2.72	1.36
129.	N-Nitrosodiethylamine	1.36	1.28	2.72	1.36
130.	N-Nitrosodimethylamine	1.36	1.28	2.72	1.36
131.	N-Nitrosomethylethylamine	1.36	1.28	2.72	1.36
132.	N-Nitrosomorpholine	1.36	1.28	2.72	1.36
133.	N-Nitrosopiperidine	1.36	1.28	2.72	1.36
135.	5-Nitro-o-Toluidine	1.36	1.28	2.72	1.36
134.	N-Nitrosopyrrolidine	1.36	1.28	2.72	1.36
136.	Pentachlorobenzene	1.36	1.28	2.72	1.36
137.	Pentachloroethane	2.5	5	5	3.1
138.	Pentachloronitrobenzene	1.36	1.28	2.72	1.36
139.	Pentachlorophenol	6.8	6.4	13.6	6.8
140.	Phenacetin	1.36	1.28	2.72	1.36
141.	Phenanthrene	1.36	1.28	2.72	1.36
142.	Phenol	1.36	1.28	2.72	1.36
220.	Phthalic anhydride	1.36	1.28	2.72	1.36
144.	Pronamide	1.36	1.28	2.72	1.36
145.	Pyrene	1.36	1.28	2.72	1.36
146.	Resorcinol	1.36	1.28	2.72	1.36
147.	Safrole	1.36	1.28	2.72	1.36
148.	1,2,4,5-Tetrachlorobenzene	1.36	1.28	2.72	1.36
149.	2,3,4,6-Tetrachlorophenol	1.36	1.28	2.72	1.36
150.	1,2,4-Trichlorobenzene	1.36	1.28	2.72	1.36
151.	2,4,5-Trichlorophenol	6.8	6.4	13.6	6.8
152.	2,4,6-Trichlorophenol	1.36	1.28	2.72	1.36
153.	Tris(2,3-dibromopropyl) phosphate	1.36	1.28	2.72	1.36
*	sym-Trinitrobenzene	1.36	1.28	2.72	1.36
*	4-Nitroquinoline-1-oxide	1.36	1.28	2.72	1.36

* Not a BDAT List constituent.

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
SEMIVOLATILE ORGANICS (Continued)				
* m-Dinitrobenzene	1.36	1.28	2.72	1.36
* p-Phenylenediamine	1.36	1.28	2.72	1.36
* m-Cresol	1.36	1.28	2.72	1.36
* 2-Methylnaphthalene	1.36	1.28	2.72	1.36
* a,a-Dimethylphenethylamine	1.36	1.28	2.72	1.36
* 2-Picoline	1.36	1.28	2.72	1.36
* 3-Nitroaniline	6.8	6.4	13.6	6.8
* o-Toluidine	1.36	1.28	2.72	1.36
* 2-Nitroaniline	6.8	6.4	13.6	6.8
* Benzyl alcohol	1.36	1.28	2.72	1.36
* Ethyl methanesulfonate	1.36	1.28	2.72	1.36
* Benzoic acid	6.8	6.4	13.6	6.8
* Dibenzofuran	1.36	1.28	2.72	1.36
* 2-Nitrophenol	1.36	1.28	2.72	1.36
* 7,12-Dimethylbenz(a)anthracene	1.36	1.28	2.72	1.36
* Isophorone	1.36	1.28	2.72	1.36
* 4-Chlorophenyl-phenyl ether	1.36	1.28	2.72	1.36
METALS				
154. Antimony	2.8	2.8	2.8	2.4
155. Arsenic	1	1	1	1
156. Barium	0.2	0.2	0.2	0.1
157. Beryllium	0.2	0.2	0.2	0.1
158. Cadmium	0.5	0.5	0.5	0.5
159. Chromium (total)	0.7	0.7	0.7	0.3
160. Copper	0.3	0.3	0.3	0.3
161. Lead	50	5	50	2.8
162. Mercury	0.02	0.02	0.02	0.0002
163. Nickel	1.3	1.3	1.3	1
164. Selenium	2	0.5	2	0.3
165. Silver	0.4	0.4	0.4	0.4
166. Thallium	1	1	1	1
167. Vanadium	0.3	0.3	0.3	0.3
168. Zinc	0.3	0.3	0.3	0.2

* Not a BDAT List constituent.

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT		DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
TCLP METALS					
154.	Antimony	NA	NA	0.028	NA
155.	Arsenic	NA	NA	0.005	NA
156.	Barium	NA	NA	0.002	NA
157.	Beryllium	NA	NA	0.002	NA
158.	Cadmium	NA	NA	0.005	NA
159.	Chromium (total)	NA	NA	0.007	NA
221.	Chromium (hexavalent)	0.01	0.01	0.01	0.01
160.	Copper	NA	NA	0.003	NA
161.	Lead	NA	NA	0.005	NA
162.	Mercury	NA	NA	0.0002	NA
163.	Nickel	NA	NA	0.013	NA
164.	Selenium	NA	NA	0.005	NA
165.	Silver	NA	NA	0.004	NA
166.	Thallium	NA	NA	0.01	NA
167.	Vanadium	NA	NA	0.003	NA
168.	Zinc	NA	NA	0.003	NA
CA WASTE EXTRACTION METALS					
154.	Antimony	0.028	0.028	0.028	0.028
155.	Arsenic	0.03	0.03	0.03	0.03
156.	Barium	0.002	0.002	0.002	0.002
157.	Beryllium	0.002	0.002	0.002	0.002
158.	Cadmium	0.005	0.005	0.005	0.004
159.	Chromium (total)	0.007	0.007	0.007	0.007
221.	Chromium (hexavalent)	0.01	0.01	0.01	0.01
160.	Copper	0.003	0.003	0.003	0.003
161.	Lead	0.028	0.028	0.028	0.019
162.	Mercury	0.002	0.002	0.002	0.0002
163.	Nickel	0.013	0.013	0.013	0.013
164.	Selenium	0.05	0.05	0.05	0.005

NA Not analyzed.

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
CA WASTE EXTRACTION METALS (Continued)				
165. Silver	0.004	0.004	0.004	0.003
166. Thallium	0.02	0.02	0.05	0.01
167. Vanadium	0.003	0.003	0.003	0.003
168. Zinc	0.003	0.003	0.003	0.003
* Cobalt	0.006	0.006	0.006	0.006
* Molybdenum	0.006	0.006	0.006	0.006
INORGANICS				
169. Cyanide	0.49	0.5	0.49	0.46
170. Fluoride	NA	NA	0.28	NA
171. Sulfide	NA	NA	5	NA
PCBs				
200. Aroclor 1016	NA	NA	NA	0.88
201. Aroclor 1221	NA	NA	NA	0.88
202. Aroclor 1232	NA	NA	NA	0.88
203. Aroclor 1242	NA	NA	NA	0.88
204. Aroclor 1248	NA	NA	NA	0.88
205. Aroclor 1254	NA	NA	NA	0.88
206. Aroclor 1260	NA	NA	NA	0.88
DIOXINS AND FURANS				
207. Hexachlorodibenzo-p-dioxins	0.0007	0.0008	0.0011	0.0006
208. Hexachlorodibenzofurans	0.0004	0.0004	0.0006	0.0004
209. Pentachlorodibenzo-p-dioxins	0.0007	0.0008	0.0009	0.0006
210. Pentachlorodibenzofurans	0.0005	0.0005	0.0006	0.0004

NA Not analyzed.
* Not a BDAT List constituent.

TABLE D-1 (Continued)

DETECTION LIMITS FOR THE K048 AND K051 FEED SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
DIOXINS AND FURANS (Continued)				
211. Tetrachlorodibenzo-p-dioxins	0.0019	0.0022	0.0022	0.0013
212. Tetrachlorodibenzofurans	NR	0.0011	0.0012	0.0019
213. 2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.0016	0.0021	0.0021	0.0012

NR Not reported.

TABLE D-2

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT		DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
VOLATILE ORGANICS					
222.	Acetone	0.1	0.1	0.1	0.1
1.	Acetonitrile	1	1	1	1
2.	Acrolein	0.5	0.5	0.5	0.5
3.	Acrylonitrile	0.5	0.5	0.5	0.5
4.	Benzene	0.05	0.05	0.05	0.05
5.	Bromodichloromethane	0.05	0.05	0.05	0.05
6.	Bromomethane	0.1	0.1	0.1	0.1
223.	n-Butyl alcohol	2	2	2	2
7.	Carbon tetrachloride	0.05	0.05	0.05	0.05
8.	Carbon disulfide	0.05	0.05	0.05	0.05
9.	Chlorobenzene	0.05	0.05	0.05	0.05
10.	2-Chloro-1,3-butadiene	0.05	0.05	0.05	0.05
11.	Chlorodibromomethane	0.05	0.05	0.05	0.05
12.	Chloroethane	0.1	0.1	0.1	0.1
14.	Chloroform	0.05	0.05	0.05	0.05
15.	Chloromethane	0.1	0.1	0.1	0.1
16.	3-Chloropropene	0.05	0.05	0.05	0.05
17.	1,2-Dibromo-3-chloropropane	0.1	0.1	0.1	0.1
18.	1,2-Dibromoethane	0.05	0.05	0.05	0.05
19.	Dibromomethane	0.05	0.05	0.05	0.05
20.	Trans-1,4-dichloro-2-butene	0.1	0.1	0.1	0.1
21.	Dichlorodifluoromethane	0.1	0.1	0.1	0.1
22.	1,1-Dichloroethane	0.05	0.05	0.05	0.05
23.	1,2-Dichloroethane	0.05	0.05	0.05	0.05
24.	1,1-Dichloroethylene	0.05	0.05	0.05	0.05
26.	1,2-Dichloropropane	0.05	0.05	0.05	0.05
27.	Trans-1,3-dichloropropene	0.05	0.05	0.05	0.05
28.	cis-1,3-Dichloropropene	0.05	0.05	0.05	0.05
29.	1,4-Dioxane	2	2	2	2
225.	Ethyl acetate	0.2	0.2	0.2	0.2
226.	Ethyl benzene	0.05	0.05	0.05	0.05
30.	Ethyl cyanide	0.05	0.05	0.05	0.05
227.	Ethyl ether	0.05	0.05	0.05	0.05
31.	Ethyl methacrylate	0.05	0.05	0.05	0.05

TABLE D-2 (Continued)

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
VOLATILE ORGANICS (Continued)				
32. Iodomethane	0.05	0.05	0.05	0.05
33. Isobutyl alcohol	5	5	5	5
34. Methyl ethyl ketone	0.1	0.1	0.1	0.1
229. Methyl isobutyl ketone	0.1	0.1	0.1	0.1
35. Methyl methacrylate	0.05	0.05	0.05	0.05
37. Methylacrylonitrile	0.05	0.05	0.05	0.05
38. Methylene chloride	0.05	0.05	0.05	0.05
39. Pyridine	2.5	2.5	2.5	2.5
40. 1,1,1,2-Tetrachloroethane	0.05	0.05	0.05	0.05
41. 1,1,2,2-Tetrachloroethane	0.05	0.05	0.05	0.05
42. Tetrachloroethene	0.05	0.05	0.05	0.05
43. Toluene	0.05	0.05	0.05	0.05
44. Tribromomethane	0.05	0.05	0.05	0.05
45. 1,1,1-Trichloroethane	0.05	0.05	0.05	0.05
46. 1,1,2-Trichloroethane	0.05	0.05	0.05	0.05
47. Trichloroethene	0.05	0.05	0.05	0.05
48. Trichloromonofluoromethane	0.05	0.05	0.05	0.05
49. 1,2,3-Trichloropropane	0.05	0.05	0.05	0.05
231. 1,1,2-Trichloro-1,2,2-trifluoroethane	0.05	0.05	0.05	0.05
50. Vinyl chloride	0.1	0.1	0.1	0.1
215.-217. Xylenes (total)	0.05	0.05	0.05	0.05
* 2-Nitropropane	0.2	0.2	0.2	0.2
* Styrene	0.05	0.05	0.05	0.05
* 2-Hexanone	0.1	0.1	0.1	0.1
* Vinyl acetate	0.1	0.1	0.1	0.1
* 1,2-Dichloroethene (total)	0.05	0.05	0.05	0.05
* 2-Ethoxyethanol	0.05	0.05	0.05	0.05
SEMIVOLATILE ORGANICS				
51. Acenaphthalene	0.33	0.33	0.33	0.33
52. Acenaphthene	0.33	0.33	0.33	0.33
53. Acetophenone	0.33	0.33	0.33	0.33
54. 2-Acetylaminofluorene	0.33	0.33	0.33	0.33
55. 4-Aminobiphenyl	0.33	0.33	0.33	0.33

* Not a BDAT List constituent.

TABLE D-2 (Continued)

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

	BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
	SEMIVOLATILE ORGANICS (Continued)				
56.	Aniline	0.33	0.33	0.33	0.33
57.	Anthracene	0.33	0.33	0.33	0.33
58.	Aramite	0.33	0.33	0.33	0.33
59.	Benz(a)anthracene	0.33	0.33	0.33	0.33
62.	Benzo(a)pyrene	0.33	0.33	0.33	0.33
63.	Benzo(b)fluoranthene	0.33	0.33	0.33	0.33
64.	Benzo(g,h,i)perylene	0.33	0.33	0.33	0.33
65.	Benzo(k)fluoranthene	0.33	0.33	0.33	0.33
67.	Bis(2-chloroethoxy)methane	0.33	0.33	0.33	0.33
68.	Bis(2-chloroethyl)ether	0.33	0.33	0.33	0.33
69.	Bis(2-chloroisopropyl)ether	0.33	0.33	0.33	0.33
71.	4-Bromophenyl phenyl ether	0.33	0.33	0.33	0.33
70.	Bis(2-ethylhexyl)phthalate	0.33	0.33	0.33	0.33
72.	Butyl benzyl phthalate	0.33	0.33	0.33	0.33
73.	2-sec-butyl-4,6-Dinitrophenol	0.33	0.33	0.33	0.33
74.	p-Chloroaniline	0.33	0.33	0.33	0.33
75.	Chlorobenzilate	0.33	0.33	0.33	0.33
76.	p-Chloro-m-cresol	0.33	0.33	0.33	0.33
77.	2-Chloronaphthalene	0.33	0.33	0.33	0.33
78.	2-Chlorophenol	0.33	0.33	0.33	0.33
80.	Chrysene	0.33	0.33	0.33	0.33
81.	ortho-Cresol	0.33	0.33	0.33	0.33
82.	para-Cresol	0.33	0.33	0.33	0.33
232.	Cyclohexanone	2	2	2	2
83.	Dibenz(a,h)anthracene	0.33	0.33	0.33	0.33
86.	m-Dichlorobenzene	0.33	0.33	0.33	0.33
87.	o-Dichlorobenzene	0.33	0.33	0.33	0.33
88.	p-Dichlorobenzene	0.33	0.33	0.33	0.33
89.	3,3'-Dichlorobenzidine	0.66	0.66	0.66	0.66
90.	2,4-Dichlorophenol	0.33	0.33	0.33	0.33
91.	2,6-Dichlorophenol	0.33	0.33	0.33	0.33
92.	Diethyl phthalate	0.33	0.33	0.33	0.33

TABLE D-2 (Continued)

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT		DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
SEMIVOLATILE ORGANICS (Continued)					
94.	p-Dimethylaminoazobenzene	0.33	0.33	0.33	0.33
95.	3,3'-Dimethylbenzidine	0.33	0.33	0.33	0.33
96.	2,4-Dimethylphenol	0.33	0.33	0.33	0.33
97.	Dimethyl phthalate	0.33	0.33	0.33	0.33
98.	Di-n-butyl phthalate	0.33	0.33	0.33	0.33
99.	1,4-Dinitrobenzene	0.33	0.33	0.33	0.33
100.	4,6-Dinitro-o-cresol	1.6	1.6	1.6	1.6
101.	2,4-Dinitrophenol	1.6	1.6	1.6	1.6
102.	2,4-Dinitrotoluene	0.33	0.33	0.33	0.33
103.	2,6-Dinitrotoluene	0.33	0.33	0.33	0.33
104.	Di-n-octyl phthalate	0.33	0.33	0.33	0.33
105.	Di-n-propylnitrosamine	0.33	0.33	0.33	0.33
106.	Diphenylamine	0.33	0.33	0.33	0.33
219.	Diphenylnitrosamine	0.33	0.33	0.33	0.33
108.	Fluoranthene	0.33	0.33	0.33	0.33
109.	Fluorene	0.33	0.33	0.33	0.33
110.	Hexachlorobenzene	0.33	0.33	0.33	0.33
111.	Hexachlorobutadiene	0.33	0.33	0.33	0.33
112.	Hexachlorocyclopentadiene	0.33	0.33	0.33	0.33
113.	Hexachloroethane	0.33	0.33	0.33	0.33
115.	Hexachloropropene	0.33	0.33	0.33	0.33
116.	Indeno(1,2,3-cd)pyrene	0.33	0.33	0.33	0.33
117.	Isosafrole	0.33	0.33	0.33	0.33
118.	Methapyrilene	0.33	0.33	0.33	0.33
119.	3-Methylcholanthrene	0.33	0.33	0.33	0.33
120.	4,4'-Methylenebis(2-chloroaniline)	0.33	0.33	0.33	0.33
36.	Methyl methanesulfonate	0.33	0.33	0.33	0.33
121.	Naphthalene	0.33	0.33	0.33	0.33
122.	1,4-Naphthoquinone	0.33	0.33	0.33	0.33
123.	1-Naphthylamine	0.33	0.33	0.33	0.33
124.	2-Naphthylamine	0.33	0.33	0.33	0.33
125.	p-Nitroaniline	1.6	1.6	1.6	1.6
126.	Nitrobenzene	0.33	0.33	0.33	0.33
127.	4-Nitrophenol	1.6	1.6	1.6	1.6
128.	N-Nitrosodi-n-butylamine	0.33	0.33	0.33	0.33
129.	N-Nitrosodiethylamine	0.33	0.33	0.33	0.33
130.	N-Nitrosodimethylamine	0.33	0.33	0.33	0.33

TABLE D-2 (Continued)

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS			
	Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
SEMIVOLATILE ORGANICS (Continued)				
131. N-Nitrosomethylethylamine	0.33	0.33	0.33	0.33
132. N-Nitrosomorpholine	0.33	0.33	0.33	0.33
133. N-Nitrosopiperidine	0.33	0.33	0.33	0.33
135. 5-Nitro-o-Toluidine	0.33	0.33	0.33	0.33
134. N-Nitrosopyrrolidine	0.33	0.33	0.33	0.33
136. Pentachlorobenzene	0.33	0.33	0.33	0.33
137. Pentachloroethane	0.05	0.05	0.05	0.05
138. Pentachloronitrobenzene	0.33	0.33	0.33	0.33
139. Pentachlorophenol	1.6	1.6	1.6	1.6
140. Phenacetin	0.33	0.33	0.33	0.33
141. Phenanthrene	0.33	0.33	0.33	0.33
142. Phenol	0.33	0.33	0.33	0.33
144. Pronamide	0.33	0.33	0.33	0.33
145. Pyrene	0.33	0.33	0.33	0.33
147. Safrole	0.33	0.33	0.33	0.33
148. 1,2,4,5-Tetrachlorobenzene	0.33	0.33	0.33	0.33
149. 2,3,4,6-Tetrachlorophenol	0.33	0.33	0.33	0.33
150. 1,2,4-Trichlorobenzene	0.33	0.33	0.33	0.33
151. 2,4,5-Trichlorophenol	1.6	1.6	1.6	1.6
152. 2,4,6-Trichlorophenol	0.33	0.33	0.33	0.33
* sym-Trinitrobenzene	0.33	0.33	0.33	0.33
* 4-Nitroquinoline-1-oxide	0.33	0.33	0.33	0.33
* m-Dinitrobenzene	0.33	0.33	0.33	0.33
* p-Phenylenediamine	0.33	0.33	0.33	0.33
* m-Cresol	0.33	0.33	0.33	0.33
* 2-Methylnaphthalene	0.33	0.33	0.33	0.33
* a,a-Dimethylphenethylamine	0.33	0.33	0.33	0.33
* 2-Picoline	0.33	0.33	0.33	0.33
* 3-Nitroaniline	1.6	1.6	1.6	1.6
* o-Toluidine	0.33	0.33	0.33	0.33
* 2-Nitroaniline	1.6	1.6	1.6	1.6
* Benzyl alcohol	0.33	0.33	0.33	0.33
* Ethyl methanesulfonate	0.33	0.33	0.33	0.33
* Benzoic acid	1.6	1.6	1.6	1.6
* Dibenzofuran	0.33	0.33	0.33	0.33

* Not a BDAT List constituent.

TABLE D-2 (Continued)

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS			
	Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
SEMIVOLATILE ORGANICS (Continued)				
* 2-Nitrophenol	0.33	0.33	0.33	0.33
* 7,12-Dimethylbenz(a)anthracene	0.33	0.33	0.33	0.33
* Isophorone	0.33	0.33	0.33	0.33
* 4-Chlorophenyl-phenyl ether	0.33	0.33	0.33	0.33
METALS				
154. Antimony	2.4	2.4	2.4	2.4
155. Arsenic	1	1	1	1
156. Barium	0.1	0.1	0.1	0.1
157. Beryllium	0.1	0.1	0.1	0.1
158. Cadmium	0.5	0.5	0.5	0.5
159. Chromium (total)	0.3	0.3	0.3	0.3
160. Copper	0.3	0.3	0.3	0.3
161. Lead	2.8	2.8	2.8	2.8
162. Mercury	0.0002	0.0002	0.0002	0.0002
163. Nickel	1	1	1	1
164. Selenium	0.3	0.3	0.3	0.3
165. Silver	0.4	0.4	0.4	0.4
166. Thallium	1	1	1	1
167. Vanadium	0.3	0.3	0.3	0.3
168. Zinc	0.2	0.2	0.2	0.2
TCLP METALS				
154. Antimony	0.024	0.024	0.024	0.024
155. Arsenic	0.01	0.01	0.01	0.01
156. Barium	0.001	0.001	0.001	0.001
157. Beryllium	0.001	0.001	0.001	0.001
158. Cadmium	0.005	0.005	0.005	0.005
159. Chromium (total)	0.003	0.003	0.003	0.003
221. Chromium (hexavalent)	0.01	0.01	10	0.01
160. Copper	0.003	0.003	0.003	0.003

* Not a BDAT List constituent.

TABLE D-2 (Continued)

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
TCLP METALS (Continued)				
161. Lead	0.005	0.005	0.005	0.005
162. Mercury	0.0002	0.0002	0.0002	0.0002
163. Nickel	0.01	0.01	0.01	0.01
164. Selenium	0.005	0.005	0.005	0.005
165. Silver	0.004	0.004	0.004	0.004
166. Thallium	0.01	0.01	0.01	0.01
167. Vanadium	0.003	0.003	0.003	0.003
168. Zinc	0.002	0.002	0.002	0.002
CA WASTE EXTRACTION TEST METALS				
154. Antimony	0.028	0.028	0.028	0.028
155. Arsenic	0.03	0.03	0.03	0.03
156. Barium	0.002	0.002	0.002	0.002
157. Beryllium	0.002	0.002	0.002	0.002
158. Cadmium	0.004	0.004	0.004	0.004
159. Chromium (total)	0.007	0.007	0.007	0.007
221. Chromium (hexavalent)	0.01	0.01	0.01	0.01
160. Copper	0.003	0.003	0.003	0.003
161. Lead	0.019	0.019	0.019	0.019
162. Mercury	0.0002	0.0002	0.0002	0.0002
163. Nickel	0.013	0.013	0.013	0.013
164. Selenium	0.005	0.005	0.005	0.005
165. Silver	0.003	0.003	0.003	0.003
166. Thallium	0.01	0.01	0.04	0.01
167. Vanadium	0.003	0.003	0.003	0.003
168. Zinc	0.003	0.003	0.003	0.003
* Cobalt	0.006	0.006	0.006	0.006
* Molybdenum	0.006	0.006	0.006	0.006

* Not a BDAT List constituent.

TABLE D-2 (Continued)

DETECTION LIMITS FOR THE RAFFINATE SOLIDS SAMPLES
SOLVENT EXTRACTION AT PLANT Q

BDAT LIST CONSTITUENT	DETECTION LIMITS Sample Set #1 (ppm)	Sample Set #2 (ppm)	Sample Set #3 (ppm)	Sample Set #4 (ppm)
INORGANICS				
169. Cyanide	0.48	0.37	0.47	0.46
170. Fluoride	NA	NA	NR	NA
171. Sulfide	NA	NA	NR	NA
PCBs				
200. Aroclor 1016	NA	NA	NA	0.5
201. Aroclor 1221	NA	NA	NA	0.5
202. Aroclor 1232	NA	NA	NA	0.5
203. Aroclor 1242	NA	NA	NA	0.5
204. Aroclor 1248	NA	NA	NA	0.5
205. Aroclor 1254	NA	NA	NA	0.5
206. Aroclor 1260	NA	NA	NA	0.5
DIOXINS AND FURANS				
207. Hexachlorodibenzo-p-dioxins	NA	NA	NA	NA
208. Hexachlorodibenzofurans	NA	NA	NA	NA
209. Pentachlorodibenzo-p-dioxins	NA	NA	NA	NA
210. Pentachlorodibenzofurans	NA	NA	NA	NA
211. Tetrachlorodibenzo-p-dioxins	NA	NA	NA	NA
212. Tetrachlorodibenzofurans	NA	NA	NA	NA
213. 2,3,7,8-Tetrachlorodibenzo-p-dioxin	NA	NA	NA	NA

NA Not analyzed.
NR Not reported.

TABLE D-3
DETECTION LIMITS FOR CYANIDE IN THE K048 FEED SAMPLES AND
THE COMBUSTION GAS SCRUBBER DISCHARGE WATER SAMPLES
FLUIDIZED BED INCINERATION AT PLANT A

BDAT LIST CONSTITUENT	DETECTION LIMITS FOR SAMPLE SETS 1-6	
	K048 Feed Sample (ppm)	Combustion Gas Scrubber Discharge Water (ppm)
INORGANICS		
169. Cyanide	0.6	0.01